# Northern Goshawk
# Northern Region Overview
Key Findings and Project Considerations

December 2009

**Prepared by the Northern Goshawk Working Group:**

*Coauthors:*
*Lorraine T. Brewer*
*Renate Bush*
*Jodie E. Canfield*
*Alan R. Dohmen*

*Key Contributors:*

*Steve Anderson, Jim Barber, Beth Hahn, Wayne Johnson,*
*Skip Kowalski, Dave Lockman, David J. Robert,*
*Kristi S. Swisher, Eric Tomasik*

**This document will be revised periodically as new information becomes available. Check the WWFRP intranet site for the most current version.**
**http://fsweb.r1.fs.fed.us/wildlife/wwfrp/TESnew.htm**

# TABLE OF CONTENTS

# I. INTRODUCTION

## 1.1. Purpose of Overview and Multi-level Analysis

The purpose of this document is to provide Region 1 (R1 or Region) field units with: (1) existing knowledge about the northern goshawk and its habitat needs; and (2) a consistent approach to analyze available goshawk habitat and other management considerations for use during the environmental analysis process.

Specifically, this report summarizes the best available scientific information about the ecological status of the species; the estimated amounts and distribution of northern goshawk habitat in R1 (Samson 2006a; estimates updated in Bush and Lundberg 2008); the results of the 2005 R1 grid-based inventory of the species (Kowalski 2006); and a consistent methodology for conducting habitat analysis. The methods used to classify goshawk habitat at multiple-spatial levels followed the architecture supported by the R1Multi-Level Classification, Mapping, Inventory, and Analysis System (Berglund et al, 2009). This system provides a consistent methodology to classify vegetation dominance type, tree size class, and tree canopy cover for R1-VMap and data inventory data residing in FSVeg.

## 1.2. Objectives

Major objectives of this report include:

- Provide relevant information on the life history and ecology of the species
- Identify management risks and threats to the species
- Provide an overview of existing habitat estimates by Ecological Province and National Forest in R1
- Compare habitat estimates with historical conditions
- Provide an overview of existing population distribution
- Characterize the habitat conditions at detection points
- Provide a consistent methodology for conducting goshawk habitat analysis

## 1.3. Management Status

The Regional Forester identifies Forest Service Sensitive Species as those plant or animal species for which population viability is a concern as evidenced by significant current or predicted downward trends in population numbers or density and/or habitat capability that would reduce a species' existing distribution.

In 2004, the Region reevaluated the set of species that would be placed on the Sensitive Species List. A standardized process to evaluate each species was followed. In summary, this process relied on: (1) global and state rankings of species through NatureServe; (2) occurrence on National Forest (NF) system lands and species distribution; (3) species seasonal use patterns; (4) risk factors; and (5) other species considerations (Wittinger 2004). The goshawk was not placed on the 2004 Sensitive Species List based on the criteria used. It was added to the list in 2005

(Kimbell 3/31/2005) because it had been previously petitioned for listing under ESA, remained a focal point of project appeals, and was a species of special interest with certain segments of the public.

The goshawk was to remain on the list until the Region completed new data collection and evaluation, at which time its status was to be reconsidered. The work of Kowalski (2006) and Samson (2006a,b; Bush and Lundberg 2008) provided the data and evaluation on which to base reconsideration of the goshawk status as sensitive. Based on these works, the majority of the Forest Wildlife Biologists across the Region determined that the goshawk no longer met the Sensitive Species criteria and the goshawk was removed from the Region's Sensitive Species List in the summer of 2007 (Tidwell 6/17/2007).

In addition to its Sensitive Species status, eight of 13 National Forests in R1 have designated the goshawk as a Management Indicator Species (MIS) in their land and resource management plans: Clearwater, Custer, Gallatin, Helena, Idaho Panhandle, Lewis & Clark, Lolo, and Nez Perce National Forests.

The Forest Service is required by the National Forest Management Act (NFMA) to "provide for a diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives" [16 U.S.C. 1604(g)(3)(B)]. The Forest Service's focus for meeting the requirement of NFMA and its implementing regulations is to assess habitat and provide species diversity.

Environmental organizations submitted petitions in 1991 (Babbitt et al. 1991; Silver et al 1991) and in 1997 (USFWS 1998) to list the northern goshawk as threatened or endangered in the western United States. On June 29, 1998 (63 FR 35183), in response to the 1997 petition, the U.S. Fish and Wildlife Service (Service) concluded (USFWS 1998), based on the best available knowledge, that:

- There was no evidence of a declining population trend for goshawks in the western United States (west of the 100$^{th}$ meridian).
- There is no evidence that goshawk habitat is limiting the population, or that significant curtailment of the species' habitat or range is occurring.
- The goshawk continues to be well-distributed throughout its historical range.
- There are no significant areas of extirpation.
- While the goshawk uses stands of mature and older forests it is not dependent on old-growth, and uses a variety of forest habitats in meeting its life history requirements.
- Listing as endangered or threatened is not warranted.

On June 7, 2004, the Region responded to the *Petition to the Northern and Intermountain Regions of the U.S. Forest Service to Amend National Forest Plans to Protect the Northern Goshawk*, submitted by the "Center for Biological Diversity" in Portland, Oregon (March 12, 2004). The "petition" sought a "rule amending the Regional and National Forest Plans to provide regulations for the protection of the northern goshawk." The Northern Region reviewed the best available knowledge and concluded (Wittinger 2004):

- There is no need for rulemaking in order to amend forest plans. Forest plans are developed, amended and revised pursuant to NFMA and its implementing regulations (1982 NFMA planning rule).
- Actions R1 takes to analyze and protect goshawks during project analysis and all information available does not show an immediate need to amend forest plans prior to scheduled revision.

According to NatureServe (accessed 03/30/2009) the northern goshawk has a conservation status rank of G5. This indicates the species is globally secure – common, widespread and abundant. The state conservation status ranks for the five states in R1 are as follows:

**Table 1. Northern goshawk state conservation status.**

| State | Rank | Definition |
|---|---|---|
| Idaho | S4 | Apparently Secure – Uncommon but not rare; some cause for long-term concern due to declines or other factors |
| Montana | S3 | Potentially at risk because of limited and/or declining numbers, range, and/or habitat, even though it may be abundant in some areas. |
| North Dakota | SNA | State Not Assessed |
| South Dakota | S3B/S2N | Vulnerable (Breeding Population) – Vulnerable in the state due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation Imperiled (Non-breeding Population) – Imperiled in the state because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from the state |
| Washington | S3B/S3N | Vulnerable (Breeding and Non-breeding Populations) – Vulnerable in the state due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation |

The species is not considered a "species of greatest conservation need" by either the states of Montana (http://fwp.mt.gov/specieshabitat/strategy/default.html) or Idaho (http://fishandgame.idaho.gov/cms/tech /CDC/cwcs_table_of_contents.cfm), and is not contained in either of the states' Comprehensive Wildlife Conservation Strategies (CWCSs).

The northern goshawk is protected under the Migratory Bird Treaty Act. Executive Order 13186 of 2001 clarified the responsibilities of Federal agencies regarding migratory bird conservation, and these responsibilities include inventory and monitoring. In December 2008, the Forest Service entered into a Memorandum of Understanding (MOU) with the U.S. Fish and Wildlife Service on the Migratory Bird Treat Act that further clarified the Forest Service's commitment to bird conservation during forest and project-level planning.

# II. OVERVIEW OF NORTHERN GOSHAWK ECOLOGY

## 2.1. Existing Information (Species Ecology)

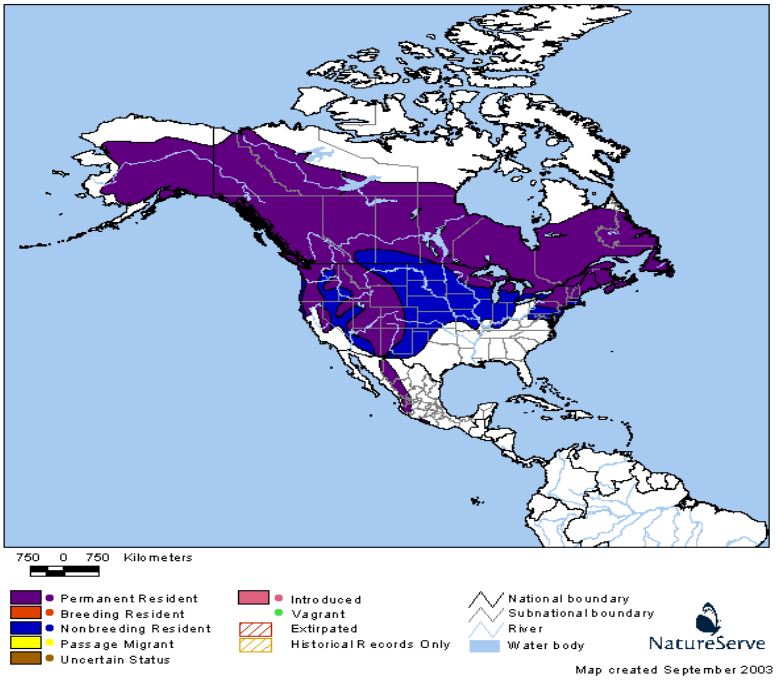
### 2.1.1. Species Description

The northern goshawk is the largest of three forest raptors in the *Accipiter* family**.** It has relatively long broad wings and a long rounded tail. Females are larger than the males. The upper parts of the adult male are brown-gray to slate gray; the head has a black cap and pronounced superciliary line; and the underparts are light gray with horizontal vermiculations and fine black vertical streaks. Undertail-coverts are white, often fluffy, with the tail dark gray above with inconspicuous broad, dark bands. Feet, toes, legs, and mouth-lining are yellow and the eye is red in adults and yellow in juveniles. Females are similar to males but browner above and more coarsely marked below, sometimes appearing barred. The upperparts of juveniles are dark brown to brown-black with a brown head. Juvenile plumage is retained throughout the first winter (Squires and Reynolds 1997).

### 2.1.2. Species Distribution

The goshawk occupies boreal and temperate forests throughout the Holoarctic. In North America, it is found breeding in a variety of habitat types in the eastern and western United States, and in portions of Alaska, Canada, and Mexico (Figure 1).

**Figure 1**. **North American goshawk distribution. "Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE."**




In R1, the species breeds in mountainous or coniferous regions throughout Montana as well as northern Idaho. Goshawks winter throughout their breeding range with a portion of the

population wintering outside regularly used areas (Figure 1). For example, wintering occurs in north central and eastern Montana but that area is not depicted as part of the species breeding range (Montana Distribution Committee 1996; Squires and Reynolds 1997).

Based on recent broad-scale habitat and inventory and monitoring assessments conducted in R1, breeding goshawks and associated habitats appear widely distributed and relatively abundant on National Forest lands (Samson 2006a, 2006b; ; Bush and Lundberg 2008; Kowalski 2006; Canfield 2006 all summarized in Section III below).

### 2.1.3. Diet

The goshawk is considered a generalist, opportunistic predator throughout its range. Prey items are taken on the ground, on vegetation, in the air, and include tree squirrels, ground squirrels, rabbits, hares, songbirds, woodpeckers, and grouse species that rely on a variety of forested and non-forested habitats (Squires and Reynolds 1997; Squires and Kennedy 2006). Goshawks have also been reported feeding on carrion, including gut piles left by hunters (Squires 1995, Wyoming). In west central Montana, snowshoe hares and red squirrels are used extensively (Clough 2000) and in Idaho, ground squirrels appear important (Patla 1997).

### 2.1.4. Home Ranges

Goshawks use large landscapes, integrating a diversity of vegetation types over several spatial scales to meet their life-cycle needs (Squires and Kennedy 2006). Breeding and non-breeding (winter) habitats can be similar, but goshawks are also known to migrate from breeding habitats during the winter.

In "The Northern Goshawk Status Review," the USFWS found that the goshawk typically uses mature forests or larger trees for nesting habitat (the nest area); however, it is considered a forest habitat generalist at larger spatial scales (USFWS 1998). The Service found no evidence in its finding that the goshawk is dependent on large, unbroken tracts of "old growth" or mature forest (63 FR 35183 June 29, 1998).

"Due to frequent bias in goshawk nest detection methods…goshawk selection of mature forests [for nesting] over other forest stages has been demonstrated in only a few studies" (Squires and Ruggiero 1996 and Clough 2000, both *in* Squires and Kennedy 2006 at p. 25). Nonetheless, the pattern of goshawk nest site selection in coniferous forests, especially mature forests with closed canopy and open understory conditions, has emerged repeatedly in numerous studies throughout western North America (Squires and Ruggiero 1996; Clough 2000). Less commonly, goshawks have also been found nesting in more open forests (USFWS 1998) as well as in small aspen stands surrounded by shrub-steppe (e.g., Younk and Bechard 1994), riparian cottonwood (e.g., White et al. 1965), and tall willow stands in the Arctic tundra (e.g., Swem and Adams 1992; summarized in Squires and Kennedy 2006 at p. 26).

The issue of goshawks selecting for some level of mature forest in the home range was the subject of recent debate in the literature. Greenwald et al. (2005) prepared a literature review of a few selected studies and concluded that goshawks select mature to older forests in their home

range. Greenwald et al. (2005) criticized Reynolds et al. (1992) on their recommendation to maintain a mix of seral stages and vegetation types that reflect historical landscape patterns. Reynolds et al. (2007) provided a rebuttal to Greenwald et al. (2005) finding that Greenwald's criticisms were based on an incomplete review of the literature; misunderstandings of the desired goshawk habitats described in the "Management Recommendations for the Northern Goshawk in the Southwestern United States" (Reynolds et al. 1992); an under-appreciation of the extent of variation in vegetation structure among forest types and seral stages used by goshawks; a limited understanding of the ecological factors limiting goshawks; and a failure to understand the dynamic nature of forest habitats. Reynolds et al. (2007) findings were consistent with the Service's 1998 status review of the species (USFWS 1998).

In North America, the size of goshawk home ranges during the nesting period may vary from approximately 1,400 to 8,650 acres, depending on factors such as sex of the bird and habitat conditions, with male home ranges typically being larger than those of females (Hargis et al. 1994; Kennedy et al. 1994). Reynolds et al. (1992) recommend home ranges of about 5,000 acres in the southwestern United States, whereas Wisdom et al. (1999) suggest home ranges in the Interior Columbia River Basin may be closer to 7,000 acres. Moser (2007) found that goshawk home ranges in northern Idaho are much larger than other regions (mean of 13,383 acres for females; 9.535 acres for males). In south-central Idaho, mean home range sizes for six males was 1,952 acres (Hasselbad and Bechard 2007). Individuals may shift and expand home ranges after breeding. Home ranges are likely not defended from other goshawks, with the exceptions of the nest area and post-fledging area (PFA). Home ranges of adjacent pairs may overlap (Squires and Reynolds 1997; Squires and Kennedy 2006).

Goshawk home ranges consist of at least three levels of habitat during the breeding season – the nest area (stand), PFA, and some amount of general habitat used for foraging, with the diversity of forest vegetative composition, age and structure increasing beyond the nest area (Reynolds et al 1992; Kennedy et al. 1994; McGrath et al. 2003; Squires and Kennedy 2006). The principle habitat attributes of nest areas, PFAs, and foraging areas are summarized below.

#### 2.1.4.1. Nest Area

The area immediately surrounding the nest tree, referred to as the nest area (analogous to the "stand") often contains alternative nests and may be reused in consecutive years (Squires and Kennedy 2006). Key findings in the literature that characterize nest areas include:

- Goshawks nest in a variety of forest types throughout their range (summarized in Squires and Reynolds 1997; USFWS 1998; Samson 2006a; Squires and Kennedy 2006).
- In general, the nest area vegetation is described by a comparatively narrower range of structural characteristics than the surrounding PFA and foraging area, i.e., mature forests, relatively closed canopies (50 to 90%), and open understories (Squires and Reynolds 1997; USFWS 1998; Samson 2006a; Bush and Lundberg 2008; Squires and Kennedy 2006).
- Average size of the nest area varies based on local habitat conditions and has been reported as ranging from 1 to 148 acres [30 acres recommended by Reynolds et al. (1992) in the southwestern United States, a range of 1 to 32 acres reported by Squires and Reynolds (1996) in Wyoming, 40 acres reported by Clough (2000) in west central Montana, ~80 acres

reported by Patla (1997) in Idaho, and 148 acres reported by McGrath et al. (2003) in northeastern Oregon and central Washington].

- No evidence exists that the goshawk is dependent on large, unbroken tracts of "old growth" or mature forest (Federal Register 63: 35183, June 29, 1998) or specifically selects for "old-growth" forest (Whitford 1991; McGrath et al. 2003) (see below). This is also substantiated at a more local level by Clough (2000) who, in a random sample of available vegetation types in west central Montana, found goshawks selected for nest stands of mature and older forest that were approximately 40 acres in size, surrounded by a mix of younger forest and non-forested openings. In R1, Canfield (2006) found similar results in an assessment of the vegetation patterns in 1700-acre sampling units where goshawks were detected during a 2005 random survey (see Section 3.1.4).

Samson (2006a) developed a goshawk nesting habitat relationship model for each Ecological Province using vegetation attributes recorded from known goshawk nest stands in R1 (point observation data, R1 POD). Table 2 displays the ranges of attributes, using R1 Vegetation Council algorithms (Barber et al, 2009), derived from stand exam data from the nest location stand or from biologists' observations, where stand exam data was not available. Table 2 data will be updated as new information becomes available.

**Table 2**. **Range of nest stand attributes by Ecological Province in R1 from point observation data of nest sites found in Region 1. (Under the Vertical Structure column, 1=single story, 2=two story, C=continuous).**

| Ecological Province | Species of Nest Tree | Canopy Cover | Vertical Structure | BA weighted mean diameter class |
|---|---|---|---|---|
| Northern Rocky Mountain Ecological Province (including the Idaho Panhandle, Kootenai, Flathead, Lolo, and Clearwater National Forests). (NRMEP) | Grand fir, subalpine fir, lodgepole pine, intolerant mix, larch, western white pine, ponderosa pine, Douglas-fir, grand-fir/cedar/ western hemlock mix, subalpine fir/spruce/mountain hemlock mix | 27-100% | 1,2,C | 7.0" + |
| Middle Rocky Mountain Province (including the Beaverhead-Deerlodge, Bitterroot, Helena, Lewis and Clark, and Nez Perce National Forests) (MRMEP) | Lodgepole pine, Douglas-fir, ponderosa pine, intolerant mix | 39–90% | 1,2,C | 8.0" + |
| Southern Rocky Mountain Province (including the Custer and Gallatin National Forests) (SRMEP) | Douglas-fir, ponderosa pine, lodgepole pine, intolerant mix | 40–100 % | 1,2 | 9.0" + |

### 2.1.4.2. Post-Fledging Area (PFA)

The PFA surrounds the nest area and, based on studies of family movement patterns, is defined as the area used by the family group from the time the young fledge until they are no longer dependent on the adults for food (Reynolds et al. 1992; Kenward et al. 1993; Kennedy et al.

1994; Kennedy and Ward 2003). Studies that corroborate the existence of a PFA, characterize its potential or known function, and habitat characteristics were summarized in Squires and Kennedy (2006) and include:

- The PFA may represent the defended portion of the home range (Reynolds et al. 1992).
- The PFA may serve as an area where young birds develop flying and hunting skills as well as protection/cover from predators (Reynolds et al. 1992; Kennedy et al. 1994; Squires and Kennedy 2006).
- The size (198 to 494 acres), shape, habitat composition, and functional importance of the PFA may vary with local conditions, such as disturbance history, prey availability, and risk of predation (Squires and Kennedy 2006).
- The area of continuous, non-fragmented forest in the PFA that surrounds the nest site may also vary with local conditions. For example studies in different parts of the country have found areas of continuous forest surrounding the nest site out to a variety of distances, such as 981 feet in west central Montana (Clough 2000), 1640 feet in Oregon and Washington (McGrath et al. 2003), 2116 feet in Arizona (LaSort et al. 2004), and 2402 feet in New Mexico (Kennedy et al. 1994). In R1, Canfield (2006) examined nest sites found during surveys of random units and noted that nest stands were situated in a variety of habitat mosaics (see Section 3.1.4).
- Some amount of mid- to late-seral forest with > 50% canopy cover and structural diversity in the understory appear important at the PFA scale (i.e., Finn et al. 2002; McGrath et al. 2003; Samson 2006a;Squires and Kennedy 2006).

Reynolds et al. (1992) used VSS diameter classes to describe PFAs in the southwestern United States which are **not readily comparable** to the diameter classes present in R1. To compare Reynolds to the studies in the northwestern United States, it was necessary to combine VSS classes 4, 5, and 6 (Reynolds et al. 1992) into one size class (> 10" dbh), which reflects mature and older forest in R1. R1 uses tree diameter classes defined in the USDA Forest Service Existing Vegetation Classification and Mapping Technical Guide, Version 1.0 (Brohman and Bryant 2005) when describing a forested stand. Tree diameter class for stands is calculated as basal-area-weighted mean diameter. These tree diameter classes are included in the spatial databases provided in R1-VMap, and they are readily derived from stand inventory data. PFA data from the studies shown in Table 3 were grouped into the diameter classes used by R1 to the greatest extent possible for comparison purposes. Table 3 also includes general recommendations for PFA habitat from Reynolds et al. (1992).

Table 3 demonstrates that PFAs are heterogeneous with large variation found in the vegetation composition of PFAs in different geographic regions (see Table 3, footnotes 1 through 6). For example, from 36.5% of PFAs in eastern Oregon to 66.0% of PFAs in west central Montana were comprised of at least 5"+ trees with >50% canopy cover. In areas where site conditions (such as moist, north slopes) can support high tree canopy covers, a canopy coverage ≥ 70% is suggested for the Northern Rocky Mountain Ecological Province, whereas >50% is suggested for the Middle and Southern Rocky Mountain Ecological Provinces (Samson 2006a).

**Table 3. Vegetation composition of PFAs in the northwestern United States compared with Reynolds et al. (1992) recommendations for the southwestern United States.** Numbers in each column = average acreage percent of PFA in each size class (stand acres/420 acres) with standard errors in parentheses ( ), where available. See footnotes for habitat conditions found in each study, including ecological province, dominant forest cover type where goshawks were found nesting, elevation, annual precipitation.

| Stand Size Class [1] and Canopy Cover | Patla (1997) [2] Southeast Idaho/Western Wyoming | Desimone (1997) [3] Eastern Oregon, | Clough (2000) [4] West-central Montana | McGrath et al. (2003: Table 15) [5] Northeastern Oregon and Central Washington | Moser and Garton (2009) [6] Northern Idaho | Reynolds et al. (1992) [7] Southwestern United States |
|---|---|---|---|---|---|---|
| 0.0 -4.9" dbh | 17.0 (4.0) | 4.2 (1.7) | 9.3 (2.9) | 3.6 (0.9) | | 10 (VSS1,2: 0-5" dbh) |
| 5.0-9.9" dbh | 6.0 (2.0) | 15.3 (2.9) | 65.7 (5.0) | 26.6 | | 20 (VSS3: 5-12" dbh) |
| 10.0"+ dbh | 66.0 (4.0) | 44.8 | 11.3 (2.6) | 62.0 | 39 (> 12"dbh) | 60 (VSS 4,5,6: >12"dbh) |
| ≥ 5.0" dbh with ≥ 50% canopy cover | | 36.5 (4.9) | 69.0 | 55.5 | 39 (> 12 " dbh, 70% canopy cover) | 60 (> than 12" dbh) |
| Openings (i.e., grass/forb/shrub) | 11.0 (~ 2.0) | | 7.3 | 8.3 | | 10 (VSS1) |

[1] Stand Size Class is based on basal area weighted average diameter (Barber et al. 2009).
[2] Patla 1997, southeastern Idaho and western Wyoming including portions of the Middle and Northern Rocky Mountain Provinces. Goshawk nests were found in Douglas-fir, lodgepole pine, or mixed conifer forests between 6102 and 7923 feet elevation that averaged 16 to 24 inches of precipitation per year at the lower elevations.
[3] Desimone (1997), eastern Oregon, Blue Mountains Province. Nests found in ponderosa pine, mixed-conifer, and lodgepole pine at 1200-2200 meters elevation (no precipitation reported).
[4] Clough (2000), west central Montana, Middle Rocky Mountain Province. Nests were found in Douglas-fir, lodgepole pine, and mixed conifer forests between 5000 and 6601 feet elevation that averaged 14 inches of precipitation per year at lower elevations.
[5] McGrath et al. (2003), northeastern Oregon and central Washington in the Blue Mountains and Eastern Cascade Provinces. Nests found in mixed conifer, Douglas-fir, ponderosa pine, western larch, lodgepole pine between 2388 and 6991 feet elevation that averaged 22 inches of precipitation per year.
[6] Moser and Garton (2009). northern Idaho, Northern Rocky Mountain Province. Numbers reported are recommended amounts derived from experimentally testing the impacts of clearcutting nest areas on goshawk reoccupancy rates 1 to 2 years post harvest.
[7] Reynolds et al. (1992), southwestern United States, management recommendations for ponderosa pine, mixed-conifer, and spruce-fir forests.

### 2.1.4.3. Foraging Area

Goshawk foraging areas have been defined in various ways in the literature, making comparisons among studies difficult (summarized in Squires and Kennedy 2006). Goshawks' use of the overall home range during the nesting season is poorly understood (Squires and Kennedy 2006). Some studies have suggested that goshawks need a narrow range of habitat conditions in the foraging area, similar to those found in the nest area (i.e., Beier and Drennan 1997; Finn et al. 2002; Greenwald et al. 2005). However, a larger number of studies have reported that goshawks use a broad-range of habitat conditions in the foraging area (i.e., Kenward 1982; Reynolds et al. 1992; Bright-Smith and Mannan 1994; Hargis et al. 1994; Beier and Drennan 1997; and

summarized in Squires and Kennedy 2006), which reflects their opportunistic, generalist diet. Salafsky et al. (2006) found that alternate prey species are commonly substituted for one another as a function of prey availability. The habitat requirements of important prey (i.e., snowshoe hare, ground squirrel, red squirrel, grouse species) include early seral to mature forests and forest openings (Squires and Kennedy 2006). Boal et al. (2005) noted that even habitats that goshawks do not appear to use (such as dense spruce/fir or small diameter, dense lodgepole pine) may be important areas for producing prey species (i.e., snow shoe hares). Goshawks have been reported hunting along the edges of forest/riparian, forest/clear-cut, and forest/grassland-sage; in non-forested openings a long distance from cover; in dense, close-canopied forest; and in open-canopied forest (recently summarized in Reynolds et al. 2007; Samson 2006a; Squires and Kennedy 2006). In Idaho, Patla (1997) found that goshawk productivity was positively related to the amount of grass/sage habitat in the home range, which supports abundant ground squirrels, a major prey species for goshawks. In northern Idaho, Moser (2007) reported goshawks foraging in or near closed canopy forests and close to streams on lower slope positions and suggested topography is important. Other key findings or conclusions in the literature that characterize goshawk foraging habitat include:

- Size of the typical home range or foraging area for the goshawk (1,409 to 8,649 acres) may vary depending on a number of factors such as age and sex of the bird, prey abundance, prey availability, local habitat conditions, etc. (Kennedy 2003).
- Goshawk foraging areas are heterogeneous and may include mature forest, as well as a mix of other forest and non-forest components (i.e., sagebrush, grasslands, lowland riparian, and agriculture) (Reynolds et al. 1992; Younk and Bechard 1994; Reynolds 1994; Patla et al. 1997; and summarized in Samson 2006a and Squires and Kennedy 2006).
- In eastern Washington, McGrath et al. (2003:48) show "the goshawk's reliance on specific habitat conditions for nesting decreases as distance from the nest increase." They found the composition of vegetative types, including tree canopy closures and size class distributions located outside the nest area blend into the surrounding landscape such that, no difference in habitat composition in occupied versus random foraging areas can be detected. In western Washington, Finn et al. (2002) found that goshawk homes ranges were more heterogeneous and had more early seral forest compared to the nest area.
- In R1, Canfield (2006) examined vegetation in random sampling units where goshawks were detected and/or nests found. She noted that all of these units had a mosaic of openings (both manmade and natural) and forest cover (see Section 3.1.4).
- Hargis et al. (1994) during a three-year study of northern goshawks in California tracked eight female and two male northern goshawks equipped with radio transmitters that provide data on foraging habitats. The intent of the Hargis et al. (1994) study was to determine those features or landscape patterns that influence northern goshawk home range size and individual use. Hargis et al. (1994) concluded that an "emphasis should be placed on creating or maintaining vegetation diversity," and "that timber harvests be designed to create a juxtaposition of seral stages."
- As addressed above, goshawks do not exclusively hunt in heavily forested areas, but have also been documented foraging in grassland/sage and other open habitats on the prey species that typically occur there.

## 2.1.5. Winter Habitat

An understanding of goshawk winter habitat is incomplete and few studies exist on this topic. Winter habitat use by goshawks is likely more variable than breeding habitat and is likely influenced by local migratory patterns (Squires and Kennedy 2006). Resident breeding pairs can remain on their breeding season home ranges during the breeding season. However, migratory populations may over-winter in very different habitats from their breeding season areas (Squires and Kennedy 2006). Currently, it is unknown how changes in landscape patterns affect seasonal changes in habitat selection (USFWS 1998).

## 2.1.6. Reproduction

Some pairs remain in their breeding season home ranges year-round. However, pairs usually return to nesting territories by March or early April, with some as early as February in some areas (Squires and Reynolds 1997). Nest construction may begin soon after birds return to territories and may commence while snow is still present (Squires and Reynolds 1997).

Typically nests are in the largest deciduous or coniferous trees of the nest area (Reynolds et al. 1982). Nest heights vary according to tree species and regional tree-height characteristics, but are typically near or just below the bottom of the live tree canopy (Squires and Reynolds 1997). The size and structure of nest trees may be more important than the species of tree for most populations. Nests typically have southerly exposures relative to the nest-tree bole. One to eight alternative nests can occur within a territory with a mean distance between alternative nests ranging from 100 to 6,780 feet (Squires and Reynolds 1997).

One clutch of eggs is laid each year beginning in late April to early May. The onset of egg-laying may be delayed by cold, wet springs as well as at higher elevations that experience delayed snowmelt compared with nest sites located at lower elevations. Incubation ranges from 28 to 32 days, with hatching occurring in late May through early June. Nestlings move to nearby branches at 34 to 35 days of age, and fledge off of the nest at 40 to 42 days of age (late June to mid-July). Once young fledge, young are not capable of sustained flights for at least 30 days, until flight feathers become fully developed and hardened. Juvenile goshawks become independent and depart from the nest area beginning at 70 days of age. Approximately 98% of fledglings disperse from the nest area by 95 days of age. Goshawks typically produce from 2.0 to 2.8 fledglings per successful nest (Squires and Reynolds 1997).

## 2.1.7. Dispersal

Dispersal includes considerations of the young moving from the nest area (natal dispersal) as well as adults moving between seasonal habitats (breeding dispersal). Successful dispersal is critical to the genetic and demographic viability of populations. Little is known about the habitats used by goshawks during dispersal, or their dispersal distances and directions (Squires and Kennedy 2006).

#### 2.1.7.1. Natal Dispersal

Natal dispersal of juvenile goshawks from the nest area involves a complex series of movements. The final natal-dispersal distance appears to be a function of the cumulative history of movements during the dispersal process (Squires and Kennedy 2006).

Unpublished data from the southwestern United States indicate a mean natal dispersal distance of 9 miles (range 2 to over 22 miles) for banded fledglings (24 of 452) that were recruited into the local population (Reynolds et al. unpubl. data in Squires and Kennedy 2006). However, natal dispersal has been documented up to 274 miles (Squires and Kennedy 2006). At the same sites in northern Arizona, the median natal dispersal distance of 89 radio-marked juvenile goshawks was 15.0 km, with a range of 0.1-58.1 km (Wiens et al. 2006a).

In R1, one record of natal dispersal has been confirmed. In 1998, a banded juvenile female, 139 days of age, was captured and released by a falconer approximately 100 miles south of the goshawk's natal nest (Clough 2000).

Kennedy and Ward (2003) suggested natal dispersal was influenced by food availability for at least the first four months post-fledging.

#### 2.1.7.2. Breeding Dispersal

Goshawk breeding dispersal includes movements between alternative nests within a breeding area and movements of individuals from one breeding area to another (Squires and Kennedy 2006). These two types of movements can only be determined when individuals are marked with color bands or fitted with radio-tracking devices (Squires and Kennedy 2006; USFWS 1998). Breeding area occupancy can vary from year to year. When individuals are not marked, the reason for non-detection of goshawks in a particular breeding area cannot be determined, thus inventory and monitoring efforts are often confounded. Like natal dispersal, detection of maximum breeding dispersal distances is likely constrained by the size of the study area and study techniques (Koenig et al. 1996; Squires and Kennedy 2006).

### 2.1.8. Inter-specific Relationships with Other Species

Inter-specific competition for habitat and prey is not well understood. Other raptors may exclude goshawks from nest areas, although goshawks and other raptors are known to nest in close proximity to one another (Squires and Kennedy 2006). In Montana for example, the great gray owl used nests built by goshawks, with the goshawk pair successfully nesting in an alternate or newly built nest nearby (Clough 2000). Numerous raptors and mammalian predators prey on many of the same species as goshawks. These predators include red-tailed hawk, Cooper's hawk, great horned owl, fox, coyote, bobcat, Canada lynx, weasel, and American marten (Squires and Kennedy 2006). Some of these competitors for habitat and prey also act as predators on goshawks; the effect of their presence on goshawks, therefore, is difficult to discern. Scientific evidence that demonstrates whether competition affects the viability of goshawk populations does not exist.

The extent to which species co-exist with goshawks may depend on the openness of the habitat (USFWS 1998). Natural and man-made changes that result in reduced forest canopy may favor the habitat needs of more open-forested competitors, such as red-tailed hawks, thereby decreasing the amount of habitat available to goshawks (USFWS 1998). Gatto et al. (2005) and Reynolds et al. (1992) indicated that goshawks have approximately 48% dietary overlap in prey species with red-tailed hawks, including prey that occupy a variety of unforested, forested, and forest edge habitats. However, La Sorte et al. (2004) noted distinct differences in how goshawks and red-tailed hawks use habitats at fine and larger landscape scales. For example, red-tailed hawks choose nest-sites on steep slopes with dense understories, enter the nest from above the canopy, and have a commanding view of the surrounding country from the nest. Conversely, goshawks choose nest-sites on moderate slopes with mature trees and open understories, enter the nest from below the canopy, and have a limited view from the nest. Red-tailed hawk nesting territories are often comprised of large open patches with scattered trees in fragmented forest, whereas goshawk nesting territories are often more continuous forest with smaller openings and edges. Theoretically then, goshawk habitat may be reduced with increased fragmentation and red-tailed hawk habitat may increase (Johnson 1992 and La Sorte et al. 2004). Whether some threshold level of fragmentation exists, beyond which red-tailed hawks completely replace goshawks is unknown. To date, no scientific studies have conclusively documented such a replacement. Reynolds et al. (1992) recommend vegetation management treatments that maintain habitat at a home range scale to sustain goshawks across landscapes.

## 2.1.9. Mortality Factors

Mortality factors include those caused by humans, such as shooting, trapping and poisoning, as well as trauma (from injuries, including collisions with motor vehicles) and natural causes, such as weather, starvation, disease/parasites, and predation by avian and mammalian species. Predators include American marten, fisher, wolverine, raccoon, and great horned owls (Squires and Reynolds 1997; Squires and Kennedy 2006). **In fact, weather, more than any other factor is thought to affect egg and nestling survival (as well as territory occupancy) more than any other factors** (Bechard et al. 2006; Keane et al. 2006; Squires and Kennedy 2006; Moser and Garton 2009; *contra* Fairhurst and Bechard 2005; Wiens et al. 2006b).

Intraguild predation in raptor assemblages, among and between diurnal and nocturnal species, is well-documented (Sergio and Hiraldo 2008). Great horned owls are considered the dominant predator of goshawk adults and young in North America because of their wide-spread distribution, abundance, and ability to prey on large raptors (Squires and Reynolds 1997; Squires and Kennedy 2006). Studies have indicated that predation on nestlings may increase during periods of low prey availability that cause female goshawks to spend more time away from the nest foraging (summarized *in* Squires and Kennedy 2006). In addition, great horned owls begin nesting earlier than goshawks and occasionally use goshawk nests, which may force goshawks to seek alternative nest areas (Reynolds et al. 1994). Researchers have speculated that because alternative nest sites are often located in close proximity, the potential for predation on goshawk young increases (summarized in Squires and Kennedy 2006). The overall effect of great horned owl predation on goshawk populations, relative to other mortality factors, is unknown (USFWS 1998).

## 2.2. Goshawk Management

## 2.2.1. Risks and Threats

### 2.2.1.1. Range-wide

Goshawk breeding populations are thought most limited by food (shown to limit reproduction), predation, and density-dependent territoriality (summarized in Squires and Ruggiero 2006). Therefore, management activities that are important to consider include those that have a negative effect on prey populations, increase goshawk's risk of predation or other mortality factors, or degrade or destroy nesting habitat within a home range. The primary influences on the amount, distribution and suitability of goshawk habitat are management treatments in forest vegetation (e.g., thinning, timber harvest) and stand-replacing wildfires (Squires and Ruggiero 2006).

The current mountain pine beetle outbreak within the Northern Region, and the associated tree mortality, poses uncertain risks to goshawk populations as a function of habitat change and loss. Data are lacking to comprehensively predict goshawk response to the beetle outbreak, though some studies do exist. Goshawk nest areas on the Ashley National Forest experienced a mountain pine beetle outbreak of approximately 100,000 acres in lodgepole pine in the early 1980s. Goshawks continued to nest successfully in lodgepole pine forests where up to 80% of the overstory trees were killed (Graham et al. 1999). The number of young that fledged on these territories from 1989 until 1996 was comparable to numbers fledged over the same time period for many other populations in the western United States (Graham et al. 1999). Similarly, the Rocky Mountain Region is currently experiencing epidemic-levels of mountain pine beetle, and have undertaken an analysis of their 2006 and 2009 regional goshawk surveys in relation to the beetle outbreak to assess short-term response.

### 2.2.1.2. Habitat Alteration Due To Timber and Fire Management Practices

Experimental data on the impacts of timber management practices on goshawk populations, including occupancy rates and adult and young survival during the breeding season are limited (Kennedy 2003); existing experimental studies show differing results, which may be explained by variable goshawk survey methods, scales of analyses, treatment sizes, and harvest intensities. We know that some level (threshold) of change in habitat can render an area unsuitable for goshawks, and that threshold may vary by geographic region (USFWS 1998). Removing nest trees, modifying or removing entire nest stands, and removing canopy, mature trees, snags, and downed wood can reduce the quality and quantity of nesting and foraging habitat (summarized in Squires and Kennedy 2006).

Several experiments from higher-productivity forests in North America and Europe have found that modification of nesting areas from timber harvest has minimal effects on goshawk reoccupancy and reproduction. In the northern Idaho portion of R1, Moser and Garton (2009) experimentally tested the impacts of clearcutting goshawk nest areas on reoccupancy and nest success for two years post-harvest; 11 of the 21 nest areas evaluated were subject to harvest.

Results suggested that in the short-term, goshawks were more likely to attempt nesting after disturbance if 39% of the PFA was left in potential nesting habitat. Once goshawks attempt nesting, success was more likely to be a function of winter and spring weather. In west-central British Columbia, Mahon and Doyle (2005) evaluated nest reoccupation rates and fledgling productivity across 79 nest areas, of which 27 nest areas were subject to clearcutting. Data were recorded prior to treatments, and nest areas were monitored for at least two years post-harvest. There were no differences in goshawk nest recoccupation and fledgling productivity rates between control and clearcut nest areas, even for those areas with more than 50% of the nest area removed. Similarly, experiments at sites in France and Italy have found minimal short-term effects of habitat loss on goshawk reproduction, provided that no more than 30% of the nest area is removed (Penteriani and Faivre 2001; Penteriani et al. 2002).

In contrast, two experimental studies found a negative relationship between harvest and goshawk nest reoccupancy and productivity. Using data from 15 nest areas in northern Arizona, of which six were subjected to harvest, Crocker-Bedford (1990) concluded that goshawk reoccupancy and productivity were much lower, compared to control nest areas. In eastern Idaho and western Wyoming, Likewise, Patla (2005) analyzed goshawk nesting occupancy and productivity in 16 nest areas, eight of which were subject to harvest, and determined that harvested nest areas had lower reoccupancy and productivity rates.

Likewise, lack of disturbance, such as fire, can result in increased densities of trees above some threshold that may render habitats unsuitable for nesting and foraging goshawks as well as some prey species (Reynolds et al. 1992, USFWS 1998, and Squires and Kennedy 2006).

Experimental data on the impacts of fire and fire suppression on goshawk populations is also lacking. We know that goshawks and goshawk prey species evolved in and continue to occupy forests that were structured by fire, including low severity/high frequency understory fires, high severity/stand-replacing fires, and a mixture of both (Brown 2000, Covington and Moore 1994). In R1 in low- to mid-elevation Douglas-fir, western larch, ponderosa pine areas, ongoing fire suppression over the past 60+ years may have caused a shift from frequent, low-intensity understory burns to stand-replacement regimes (Arno 1998, Hessberg and Agree 2003, Hessberg 2005, Schoennagel et al. 2004, Sala et al. 2005). An uncharacteristic increase in saplings provide ladder fuels that allow fires to spread to the crowns and burn over larger areas compared to earlier times, especially under severe drought conditions such as in recent years.

Reynolds et al. (1992) and Graham et al. (1999) have suggested that the use of controlled fire and thinning may improve habitat for goshawks by creating favorable conditions for goshawks and their prey (i.e., promoting diameter growth in overstory trees, creating open understories, downed wood, snags, and stimulating grass/forb/shrub growth). Conversely, in lodgepole pine and subalpine fir areas that typically regenerate through infrequent stand replacing events (100 to 350 years), fire suppression has likely had little, if any, influence on the structure and function of goshawk habitat (Agee 2000). Drought in recent years may influence wildfire size and intensity in these areas.

Findings and conclusions on the effects of vegetation management and fire suppression include:

## 1. Vegetation management

- Vegetation management is the primary human-related activity that impacts goshawk populations. It may improve or degrade habitat (Squires and Kennedy 2006).
- Reducing canopy cover below a certain threshold, which may vary by geographic region, in close proximity to occupied nests can increase solar radiation, reduce buffering from adverse weather, increase vulnerability to predators, and affect nest success (USFWS 1998).
- Timber harvest associated with fine-scale physiographic features such as slope, aspect, riparian vegetation, water, and other features found important to goshawks may have a disproportionate effect on nest area suitability (USFWS 1998).
- Several experiments from higher-productivity forests in North America and Europe have found that modification of nesting areas from timber harvest has minimal effects on goshawk reoccupancy and reproduction (Penteriani and Faivre 2001; Penteriani et al. 2002, Mahon and Doyle 2005, and Moser and Garton 2009). In contrast, two experimental studies found a negative relationship between harvest and goshawk nest reoccupancy and productivity (Crocker-Bedford 1990 and Patla (2005).. , . Small 30- to 40-acre nest stands comprised of mature forest have been used successfully by nesting goshawks (Reynolds et al 1992, southwestern United States; Woodbridge and Detrich 1994, northern California; Squires and Ruggiero 1996, Wyoming; Clough 2000, west central Montana). However, the amount of contiguous forest (> 5.0 dbh with >50% canopy cover) around nest sites may be important to site occupancy [i.e., Woodbridge and Detrich (1994) recommend no less than 84 acres].
- Specific effects of forest management on prey populations and prey availability vary by species, and those effects, which could be positive or negative, are poorly documented (Squires and Kennedy 2006).
- Since the habitat of many prey species are linked to structural habitat components such as snags, downed wood, and vegetative diversity in the understory as well as on a landscape scale, maintaining these components through silvicultural prescriptions (e.g., project design) may be important (Reynolds et al. 1992; USFWS 1998).
- To the extent feasible, vegetation treatments should be consistent with natural forest patterns, by forest type, and consider spatial arrangement and micro-site requirements (Squires and Kennedy 2006).

## 2. Fire Management

- Higher tree densities, and a decrease in under story vegetation has altered or degraded habitat in dry Douglas-fir/ponderosa pine ecosystems (Arno 1998, Hessberg and Agree 2003, Hessberg 2005, Schoennagel et al. 2004, Sala et al. 2005).
- Past fire suppression in northern lodgepole pine and subalpine forests has had little effect on goshawk habitat based on fire regimes (in Squires and Kennedy 2006).
- In warm and dry forest communities reducing tree densities by thinning from below, before prescribed fire is applied, may reduce forest fuels while simultaneously creating stand conditions that are favorable for goshawk nesting and foraging (Reynolds et al. 1992, Squires and Kennedy 2006).

- Prescribed fire treatments should be consistent with natural forest patterns, by forest type, and consider spatial arrangement and micro-site requirements (Reynolds et al. 1992, Squires and Kennedy 2006).

#### 2.2.1.3. Response to Human Activities

The effects of human disturbance near nest sites, inside or outside the breeding season, are not well documented.

In its status review of the species, the USFWS determined that at the larger population level, human disturbance does not appear to be a significant factor affecting the long-term survival of the goshawk (USFWS 1998). However, survival estimates are not well documented, and we do not understand how environmental or human factors affect survival (Squires and Kennedy 2006).

At the local level, human disturbance near nests, particularly during incubation, can cause nest failure (Boal and Mannan 1994). For example, heavy equipment operation (i.e., log loading and skidding) within 330 feet of a nest has been shown to result in the adults abandoning the nest area, even with 20-day old nestlings present (Squires and Kennedy 2006). If adults abandon a nest with eggs or nestlings present, the eggs or nestlings will die from exposure, starvation, and/or predation. In addition, recreation activities that occur near nests, such as camping, have been reported to cause nest failures (Squires and Kennedy 2006). On the other hand, Zirrer (p. 1947 *in* Squires and Kennedy 2006) noted repeated renesting attempts by goshawks despite extreme disturbance.

In northern Idaho, Moser and Garton (2009) found that clearcutting the nest area that occurred outside the breeding season (after August 15$^{th}$) in goshawk PFAs had no short-term effects (1 to 2 years after treatment) on breeding area reoccupancy as long as adequate nesting habitat was available. However, Moser and Garton recognized that because of a number of confounding factors (such as variation in weather) long-term monitoring may be necessary to detect changes in occupancy rates relative to forest management (also see Reynolds et al. 2007; Woodbridge and Hargis 2006).

McGrath et al. (2003) found that goshawks in central Washington and northeastern Oregon (n = 82) occurred closer to human disturbances (i.e., forest roads) compared with random sites, with productivity levels well within the ranges reported for other studies throughout the western United States. McGrath stated that human disturbance does not appear to be a factor for the northern goshawk as long as 70% of the nest area structure is maintained and timber management operations are restricted to avoid activity during breeding and fledging time periods.

#### 2.2.1.4. Nest/PFA Buffers and Activity Timing Restrictions

Buffering goshawk nests and PFAs from human disturbances associated with timber harvest has been debated in the literature. Based on nest area characteristics and observations of goshawk activity during the breeding season, early recommendations for protecting goshawk nest sites ranged from maintaining a 20-acre uncut buffer of mature timber (Reynolds 1983) to a 121-acre

buffer (Fowler 1988). Crocker-Bedford and Chaney (1988) and Crocker-Bedford (1990) evaluated the use of the 20-acre uncut buffers in Arizona and reported declines in the number of occupied territories in areas that had been selectively harvested. Although results are not statistically rigorous due to inconsistent survey methods, they do suggest that the use of small buffers as a management tool alone is insufficient to protect goshawks (Crocker-Bedford and Chaney 1988; Crocker-Bedford 1990). In 1992, a Scientific Committee developed management recommendations for the southwestern United States that considered nest area protection (30 acres), activity timing in PFAs, and recommended habitat parameters at the PFA and home range scales (Reynolds et al. 1992).

Subsequent studies of actual home range, PFA, and nest area use by adult and juvenile goshawks fitted with radio-transmitters support the use of nest area buffers in conjunction with management considerations at larger scales. First, Hargis et al. (1993) found that nest areas are indeed a focal point for goshawk activities during the courtship, incubation and the nestling stages. They affirmed that protection of the nest area was important because of its use by nesting goshawks for many, subsequent years. They further suggested that many goshawk activities that may be critical to recruitment and survival, such as foraging, parental care of fledglings, and roost sites, occur away from the nest site, and these activity areas (referring to the PFA) need to be considered in management plans. They also suggested providing a diversity of habitats outside the nest area, similar to those recommended by Reynolds et al. (1992).

Kennedy et al. (1994) found that during the fledgling-dependency period (from approximately mid-July to mid-August), nearly 90% of the juveniles' locations (**N** = 193) occurred within 656 ft of the nest tree, the approximate radius of a 30-acre circular nest area. During this same time period (mid-July to mid-August), they found 99.5% of the locations within 2625 ft of the nest, the approximate radius of a 425-acre circular PFA. From approximately August 15 to September 15 only 34.3% of the locations (N = 108) were within the nest area, with 75.9% of the locations outside the nest area, but within the PFA.

Fledgling movements outside the nest area by goshawk juveniles (and other raptor species) are abrupt, beginning in mid-August (Kenward et al. 1993, Reynolds et al. 1994, Tyack et al. 1998, Kennedy and Ward 2003). These abrupt movements by juvenile raptors coincide with the hardening of flight feathers that become fully developed at 65-days post hatching, at which time the juveniles are capable of long periods of sustained flight and are no longer dependent on adults for food (Kenward et al. 1993, Reynolds et al. 1994, Tyack et al. 1998, Kennedy and Ward 2003).

Activity timing recommendations vary among researchers. Reynolds et al. (1992 at p. 24, southwestern U.S.) recommend "no adverse management activities in the PFA during the nesting season, March 1 – September 30." They do recommend thinning and burning in the PFA to meet desired stand conditions (Reynolds et al. 1992). Penteriani and Faivre (2001, eastern Europe) recommend restricting activities from February to August. Others have suggested restricting timber management operations to avoid activity during the breeding through fledging time periods (McGrath et al. 2003, eastern Oregon; McGrath pers. comm.). Fledging dates can vary by geographic area, elevation, or spring weather. In western Montana, Clough (2000) found a random sample of breeding goshawks began incubating eggs on May 5 (+- 1.42 days 90% CI);

hatched June 6 (+-1.42 days); and fledged July 12 (+-1.42 days). On average then, goshawks in Clough's study were likely capable of sustained flight by August 10 (+-1.42 days), 65 days-post hatching. In northern Idaho (R1), Moser and Garton (2009) experimentally tested the impacts of clearcutting the nest area on goshawk re-occupancy rates and productivity and found that re-occupancy of the nest area was not impacted 1 to 2 years post harvest provided harvest activities occurred after August 15th and adequate nesting habitat remained in the PFA post-treatment. Spring temperatures, rather than changes in forest structure, were more related to changes in productivity. Given the above, localized data may be used to substantiate entry into the PFA prior to September 30, if nest areas are adequately protected, suitable displacement habitat occurs in and adjacent to the PFA, and the composition of the PFA post-treatment provides a diversity of habitat similar to Reynolds et al. (1992) recommendations (discussed below).

***Summary and Key Findings***

- Goshawks nest in a variety of forest types throughout their range; however, nest areas include a narrower range of habitat conditions than the PFA or foraging area, and are typically characterized by mature trees with relatively high canopy cover and open understories.
- Small 30- to 40-acre nest stands comprised of mature forest have been used successfully by nesting goshawks (Reynolds et al 1992, southwestern United States; Woodbridge and Detrich 1994, northern California; Squires and Ruggiero 1996, Wyoming; Clough 2000, west central Montana). However, the amount of contiguous forest (> 5.0 dbh with >50% canopy cover) around those nest sites may be important to site occupancy [i.e., Woodbridge and Detrich (1994) recommend no less than 84 acres].
- Foraging areas are heterogeneous and include a variety of habitats and seral stages.
- Forest management can either degrade or enhance goshawk habitat.
- Goshawk response to disturbance from vegetation treatments and human activities near nests is inconclusive and may vary from complete site abandonment and nest failure to some level of tolerance.
- Limited data suggests goshawks can tolerate some level of vegetation management in occupied PFAs outside the nesting period.
- Goshawk researchers suggest silvicultural and prescribed fire treatments should be consistent with natural forest patterns and fire regimes.

### 2.2.1 Scientific Uncertainty (including a discussion of Reynolds et al. 1992)

Based on a review of goshawk ecology Squires and Kennedy (2006) conclude that many life-history attributes remain unknown and it is a daunting task to gain precise, scientific knowledge on top-level predators such as the goshawk. As an example, Squires and Kennedy (2006) note that Reynolds et al. (1992) have sustained repeated criticism (i.e., see Greenwald et al. 2005 and Beier et al. 2008), but the management recommendations for sustaining nest areas, PFAs, and foraging areas in the southwestern United States have held up to a high level of scrutiny, including in the courts.

Reynolds et al. (2006) reviewed their 1992 management recommendations for conserving goshawks in the southwestern United States. They believe the overarching approach and

procedures presented in the 1992 recommendations can be adapted to other geographic regions, based on more region-specific information. They recognize that specific forest conditions among different geographic regions likely differ because of varying ecological conditions (such as, climate, soil, disturbance history) that effect the overall composition, structure, pattern and dynamics of vegetation among Forests and Regions (Reynolds et al. 2006). Reynolds et al. (2006) concluded that his 1992 recommendations are sound, economically reasonable, and due to the diversity of the strategy's components, which take an ecosystem management approach, they are robust for sustaining goshawks. They also realize there are uncertainties in forest management as goshawk and prey habitat management is a long-term approach.

Specific effects of forest management on prey populations and prey availability vary by species, and those effects, which could be positive or negative, are not well understood (Squires and Kennedy 2006). Wiens and Reynolds (2006) found that food availability was the primary factor limiting juvenile survival. They concluded that forest management prescriptions designed to support abundant prey populations while providing forest structural conditions that allow goshawks to access their prey within breeding areas should benefit juvenile survival. Since the habitat of many prey species are linked to structural habitat components such as snags, downed wood, and vegetative diversity in the understory as well as on a landscape scale, maintaining a diversity of components through silvicultural prescriptions (e.g., project design) may be important (Reynolds et al. 1992; USFWS 1998).

With the high costs associated with experimentally testing the 1992 management recommendations, Reynolds et al. (2006) suggest implementing the recommendations in broad landscapes to sustain goshawks while restoring management-altered ecosystems rather than waiting for experimental tests of the 1992 recommendations' effectiveness.

Squires and Kennedy (2006) conclude there is no evidence that North American goshawk populations are declining. However, they can't separate the hypotheses given the nature of the available evidence: the goshawk is not declining, or the goshawk is declining but there is not sufficient information to detect the decline.

McGrath et al. (2003) point out some controversy that still exists surrounding the goshawk as an indicator species for old growth. Their study indicated that the old-growth forest structural stage was not useful in determining goshawk nest site selection, which corroborates the findings of Whitford (1991), which took place in R1. McGrath et al. (2003) also suggest the practice of placing small, no-harvest buffers around goshawk nests as a management tool by itself will be ineffective at maintaining site suitability, without considering habitat alterations beyond the buffer. Given appropriate silvicultural prescriptions and timing that does not conflict with the nesting season, McGrath et al. (2003) believe, it should be possible to manage timber stands (but requiring careful, long-term planning) at varying distances from goshawk nests, including light thinning (fuels reduction) near the nest. However, studies of goshawk's response to thinning in the nest stand are inconclusive at this time [summarized in Squires and Kennedy (2006)].

# III. SCOPE AND LEVEL OF SPECIES ASSESSMENTS

R1's approach for assessing a species and its habitat is to consider multiple analysis levels. Several broad-level analyses, which encompass Forest Service lands in the entire Region, or by Ecoprovince or Forest have been completed. Broad level analyses aid in placing a species in context at the larger population level and address NFMA requirements. Smaller level analysis such as at the goshawk home range, 6th field hydrologic unit, or landscape levels may form the basis for analyzing project-level and cumulative effects to address NEPA requirements.

## 3.1. R1 Broad-level Analyses

Three broad-level analyses for the northern goshawk were completed in the Region in 2005 and 2006 including: (1) a conservation assessment (Samson 2006a; estimates updated in Bush and Lundberg 2008) that summarized all known historical and recent habitat and population information and provided estimates (for each National Forest) of nesting, PFA, and foraging area habitat; (2) development of habitat estimates for maintaining viable populations of northern goshawk in the Region (Samson 2006b; Bush and Lundberg 2008); and (3) a Region-wide 2005 survey that provided estimates of goshawk occupancy and distribution during the breeding season (Kowalski 2006). Results of each broad-level analyses follow and should be considered for setting the context of impacts of management activities.

### 3.1.1 Habitat Assessment (Regional Conservation Assessment)

Samson (2006a; updated by Bush and Lundberg 2008) summarized current goshawk habitat in R1 and compared this amount with the amount of habitat believed to exist prior to European settlement. Samson (2006a) concluded that forests have changed since European settlement (see Hessburg and Agee 2003; Hessburg et al. 2004). In addition, the area of forest has increased; fire regimes have lengthened in time interval and changed in pattern (larger and more intense at least in lower elevation forests); Douglas-fir, grand fir and other shade tolerant species have increased in abundance and distribution; intermediate but neither young or old forest structures are more abundant and well-distributed; and increased forest connectivity is placing patches of mature and late-seral forests at risk. This is because mature or older forest patches no longer persist in fire-protected refugia but are embedded in a matrix of intermediate-aged forest that permits the rapid spread of fire and insect outbreaks with a spatial-temporal pattern unlike the historical landscape.

Among the three primary patterns in fire, the natural regime for low severity fire has changed (longer interval) in low elevation, primarily ponderosa pine, forest, and some change, particularly in low elevation mixed conifer forests, is reported in the natural regime for mixed severity fire (combination of low severity and high severity fire) (Schoennagel et al. 2004). Frequency and patterns in high severity fire characteristic to high elevations may still be within their natural range of variation.

### 3.1.1.1 Habitat Estimates

Northern goshawk habitat estimates in R1 by Province and Forest are disclosed in Samson 2006a, Appendix 3 (see also updated estimates in Bush and Lundberg 2009). Some conclusions are as follows:

- Assuming one to five nests are constructed by the northern goshawk within the home range, available nesting habitat ranges from 1,006 acres on the Custer National Forest, or enough habitat to support 7 to 34 breeding pairs, to 53,685 acres on the Beaverhead-Deerlodge National Forest, or enough habitat to support 362 to 1,811 breeding pairs (see Table 9 *in* Samson 2006a:34, updated by Bush and Lundberg 2008).
- The amount of habitat for PFAs ranges from 34,449 acres on the Flathead National Forest, or enough habitat to support 58 to 116 breeding pairs, to 363,593 acres on the Beaverhead-Deerlodge National Forest, or enough habitat to support 613 to 1,226 breeding pairs (see Table 9 *in* Samson 2006a:34, updated by Bush and Lundberg 2008).
- Foraging area habitat (assuming no overlap occurs between breeding territories) ranges from 97,586 acres on the Custer National Forest, or enough habitat for about 23 pairs to 976,089 acres on the Beaverhead Deerlodge, or enough foraging habitat for about 229 pairs (see Table 9 *in* Samson 2006a, and updates in Bush and Lundberg 2008). Other Forests in the Region fall within this range. Note, goshawk foraging habitat estimates in R1 are extremely conservative, as Samson (2006a; Bush and Lundberg 2008) only quantified foraging habitat as forested with >40% canopy cover. Based on a large body of research which documents goshawk foraging behavior and habitat preferences of goshawk prey, we know goshawks forage in a variety of forested and non-forested environments.
- Habitat models for nesting area and PFA were developed by Samson (2006a; Bush and Lundberg 2008) and applied to Forest Inventory and Analysis (FIA) data to derive estimates of nesting and PFA habitat by National Forest in each of three ecological provinces that encompass R1; the Northern Rocky Mountain Steppe, Middle Rocky Mountain Steppe, and Southern Rocky Mountain Steppe (Bailey 1996 *in* Samson 2006a; Bush and Lundberg 2008).
- FIA data provides statistically reliable estimates at the Regional and Forest levels down to geographic areas of approximately 60,000 acres in size. Estimates of habitat from FIA data provide broad-level cumulative effects information as directed by NFMA. This information is useful in setting the context for the possible effects of a project. However, finer-level vegetation analysis, such as can be done with stand exam data, is necessary to quantify and map goshawk habitat at the project level, using variables or combinations of variables similar to those used in the FIA models (Samson 2006a; Bush and Lundberg 2008).

### 3.1.1.2. Distribution of Habitat

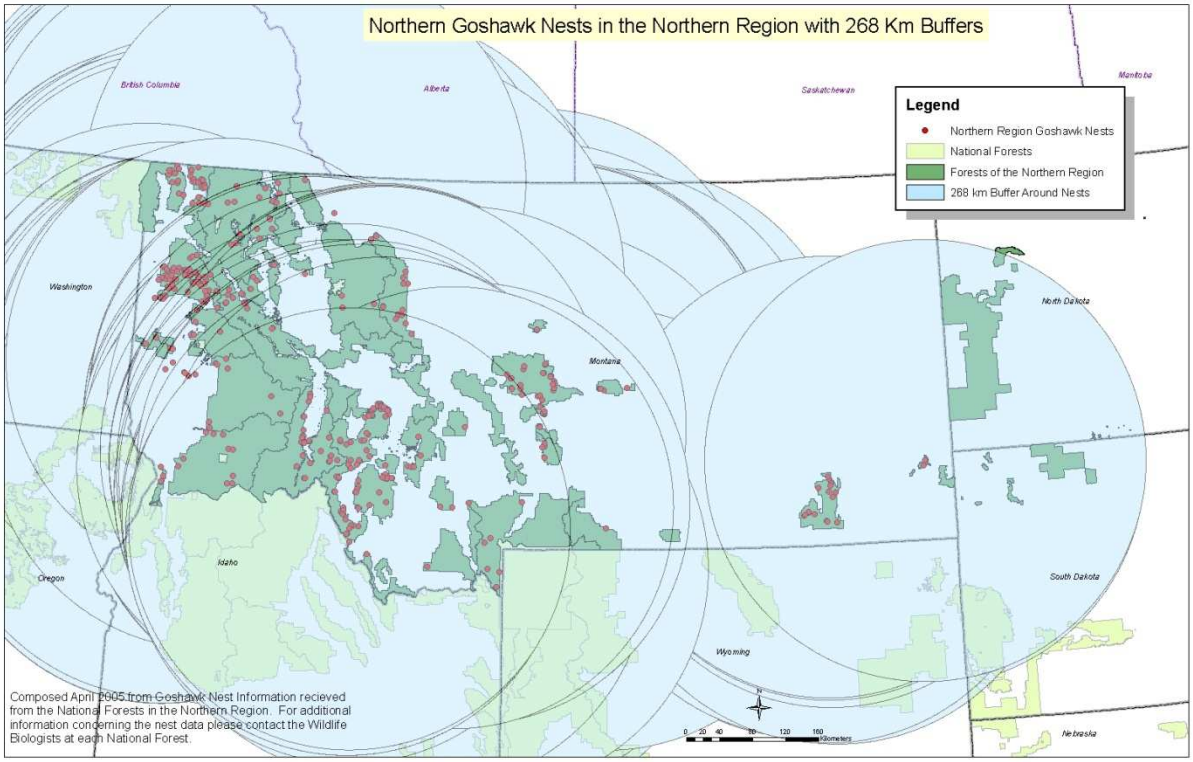
Dispersal ability of young is the measure of well-distributed habitat (Thomas et al. 1990, Appendix P) and an important component of population viability, yet is difficult to measure (Koenig et al. 2000).

In an overall review of dispersal distance in birds, Bowman (2003) found a relationship between median dispersal distance and the square root of territory size for a species [median dispersal distance (in km) = 12 times the square root of the territory size in ha].

In the President's Plan to conserve the old-growth forests of the Pacific Northwest, Thomas et al. (1992:367) concluded for the spotted owl that "the distances between Habitat Conservation Areas should be within the known dispersal distances of at least two-thirds (67%) of all juveniles."

Samson (2006a) determined that 2/3 of the median dispersal distance of juvenile goshawk results in a distance of 166.5 miles, using the square root of a minimum territory (home range) size of 1,235 acres and multiplying by 12 (Bowman 2003). This buffer was placed around the known goshawk nests in R1, showing that not a single known nest site is isolated from another known nest (Figure 2).

**Figure 2**. **Northern goshawk nests in R1 with a 166.5-mile buffer equal to 2/3 of the median dispersal distance of juvenile goshawks**.




## ***Summary and Key Findings***

- Goshawk habitat in R1 is abundant and well distributed where it occurs naturally, and more forest, and therefore nesting habitat, exists on today's landscape than what occurred historically (Samson 2006a; Bush and Lundberg 2008).
- There have been substantial increases in connectivity for forested habitat since Euro-American settlement (Samson 2006a).
- The level of timber harvest of the forested landscape in R1 is insignificant (Samson 2006a).
- The suppression of natural ecological processes has increased and continues to increase the amount of forested habitat (Samson 2006a).

- Existing demographic data are inadequate to determine goshawk population trend (Kennedy 1997; USFWS 1998; Kennedy 2003; Andersen et al. 2005; Squires and Kennedy 2006).
- Not a single known nest site in R1 is isolated from other known nests by more than the goshawks' estimated dispersal distance.
- Samson (2006a; Bush and Lundberg 2008) estimated the amount (by hectare) of nesting, post-fledgling and foraging habitat by National Forest (mid-level) from both a Regional and province basis using habitat relationship models and FIA data.

### 3.1.2 Habitat Thresholds

Samson (2006b; Bush and Lundberg 2008) developed habitat estimates for maintaining viable populations of northern goshawks in R1. Estimating a habitat threshold for maintaining viable populations is difficult and requires separating the effects of habitat loss and fragmentation (Fahrig 1997). Fahrig (1997) suggests that habitat loss and not fragmentation has consistent negative effects on species persistence. Two model-based estimates suggest a "threshold" effect on species persistence is reached when approximately 20-30% of the historical habitat remains on the landscape (Fahrig 1997; Flather and Bevers 2003). These model-based estimates do exceed the 10% minimum ecosystem threshold recommended by the International Union for Conservation of Nature and Natural resources (IUCN 1980) and others to maintain native species. Nevertheless, empirical evidence to support any threshold concept is limited (Jansson and Angelstam 1999). An alternative approach to the 20-30% threshold of historical habitat is to estimate the amount of habitat required to maintain a viable population for a species (Samson 2006b; Bush and Lundberg 2008).

In determining habitat estimates for maintaining viable populations, Samson (2006b; Bush and Lundberg 2008) used the goshawk PFA as the critical amount of habitat since goshawks actively defend the PFA. A size estimate of 545 acres was used based on Reich et al. (2004). A net effective ($N_e$) population size of 110 was determined based on interpretations from Allendorf and Ryman (2002). Using these variables (dividing 110 by 2 to account for a breeding pair), Samson (2006b) determined a total critical habitat estimate of 30,147 acres for a minimum viable population for northern goshawks within R1. In actuality, the R1 goshawk population is not isolated, but is part of the entire species' range that extends in all directions from R1.

Table 4 compares the 30,147-acre minimum viable population habitat threshold for the Regional population to the estimated available PFA and nesting habitat amounts (based on FIA plot data) on each National Forest, the total by ecological province, and the Region 1 total (Samson 2006b, with errata corrected by Bush and Lundberg 2008). Note that all 12 National Forests contain estimated habitat amounts that exceed the threshold estimated for the entire R1. FIA data plots that had received any type of vegetation treatment or wildlife since time of inventory through November 2003 were excluded from calculations.

**Table 4. Summary of northern goshawk estimated post fledgling area habitat by National Forest, Province and Region 1.**

| Forest/Geographic Area | Forest # | Acres Goshawk PFA Habitat |
|---|---|---|
| Beaverhead-Deerlodge | 02 | 363,593 |
| Bitterroot | 03 | 160,714 |
| Idaho Panhandle | 04 | 148,354 |

| Forest/Geographic Area | Forest # | Acres Goshawk PFA Habitat |
|---|---|---|
| Clearwater | 05 | 62,012 |
| Custer | 08 | 36,218 |
| Flathead | 10 | 34,449 |
| Gallatin | 11 | 109,169 |
| Helena | 12 | 121,641 |
| Kootenai | 14 | 63,694 |
| Lewis & Clark | 15 | 163,891 |
| Lolo | 16 | 54,848 |
| Nez Perce | 17 | 275,166 |
| Northern Rocky Province | 03 ,04, 05, 10, 14, 16 | 400,104 |
| Middle Rocky Province | 02, 12, 15, 17 | 915,531 |
| Southern Rocky Province | 08, 11 | 145,391 |
| Region 1 in Total | All | 1,590,589 |

* Acres cited here are based on the most current estimate available on 09-02-08 (Bush and Lundberg 2008). All plots with any type of vegetation management or wildlfire through November 2003, were removed from the calculations. Acres are subject to change as updates become available.

***Summary and Key Findings***

- The northern goshawk is secure in terms of persistence (http://www.natureserve.org/explorer/serve/NatureServe; accessed March 30, 2009.
- Below (and not above) a threshold of 20 to 30% of historical habitat amounts, the effects of fragmentation (i.e. patch size and isolation) are suggested to have a negative impact on species persistence. No indication exists that forested ecosystems in R1 have reached the 20 to 30% threshold of historical.
- Forested systems in R1 are more extensive and are less fragmented than in historical (~1800 A.D.) times from an increase in conifers into grasslands (Hessburg and Agee 2003; Gallant et al. 2004; Hessburg et al. 2005).
- The effects of habitat fragmentation on birds are less in the western United States compared to the Midwestern and eastern United States because western landscapes were naturally more fragmented in historical times.
- A comparison of habitat estimates for maintaining viable populations to that available on each Forest indicates that habitat is available in excess to that needed, given the natural distribution of the species and its habitat as mapped and according to the scientific literature (Samson 2006b; Bush and Lundberg 2008).

## 3.1.3 Goshawk Occupancy and Distribution Survey – 2005

During the 2005 breeding season, R1 piloted the "Northern Goshawk Bioregional Monitoring Design," a grid-based survey protocol developed by Woodbridge and Hargis (2006) based on a random sampling design with suggestions for stratification by habitat quality and ease of access. The purpose of survey was to employ a statistically-based approach to: (1) estimate the rate of goshawk occupancy (frequency of presence) within a grid that approximates the territory size for the species (1,700 acres); and (2) better define and document the geographic distribution of

goshawks across R1. Additional survey data was needed in R1 to strengthen and augment the statistical reliability of existing Forest field data on the species; and complement the Region-wide Conservation Assessment of the Northern Goshawk developed by Samson (2006a; Bush and Lundberg 2008).

R1 used a simplified random sample approach using 1,700-acre Potential Sampling Units (PSUs) overlaid in a grid-fashion on National Forest System (NFS) lands that had road access to within at least one mile of the edge of the PSU (Woodbridge and Hargis 2006). Of the 17,750 total PSUs, 12,350 were included in the sampling frame (Kowalski 2006). Sampling points occurred within wilderness, roadless and other remote areas; however, by design we were unable to draw statistical inferences regarding goshawk occupancy in PSUs that "totally" lacked road access.

Every Forest in the Region had detections, except the Bitterroot and Clearwater. However, based on local surveys, goshawks are known to occur on these Forests during the breeding season. Because detecting goshawks can be difficult, goshawk presence may actually be under-estimated (Reich et al 2004; Reynolds et al. 2007). Additional surveys may be needed to obtain a more accurate estimate of goshawk presence on territories (Reynolds et al. 2007).

The following links provide maps showing the distribution of goshawk nests active from 2000 to 2006 and the results of the 2005 survey effort:

http://fsweb.r1.fs.fed.us/wildlife/wwfrp/wildlife/goshawk/NGoshawkNests_00_05.pdf
http://fsweb.r1.fs.fed.us/wildlife/wwfrp/wildlife/goshawk/RA_NGoshawkResults.pdf

***Summary and Key Findings***

- Based on a 2005 random sample (n=114) of 12,350 sampling units, one would expect to detect goshawks in 39% +- 10% (95% confidence interval) of available habitat located in road-accessible areas in R1 (Kowalski 2006).
- Results suggest goshawks are relatively common and widely distributed in the roaded (more managed) portions of NFS lands. Results were consistent with Clough (2000) and McGrath (2003) who documented goshawks successfully breeding in areas associated with roads.
- Periodic follow-up surveys may be necessary to study changes or trends in occupancy.
- The data was useful in evaluating the status of the goshawk as a Regional "Sensitive" Species in conjunction with other available science.
- The data aid in setting the regional and forest context during the environmental analysis process for land management projects.
- Results reinforce the conclusions of Samson (2006a,b; Bush and Lundberg 2008) who, using habitat relationship models and FIA data, determined habitat for goshawks at the Regional, province, and Forest scales is abundant and well-distributed.
- The intensity of Forest or District-level survey/inventory work varies across R1, but generally indicates that goshawks occur throughout the region in a variety of biophysical settings.

## 3.2. Considerations for Project Analysis

This section provides a consistent means of conducting effects analysis at the project level. **An analysis should be completed if project activities would have measurable direct, indirect, and or cumulative effects on goshawk nesting or foraging (summer) habitat and/or adults and young during the breeding season (see sections 2.1.6, 2.2.1.3 and 2.2.1.4 for a discussion of reproduction and human caused disturbance during the breeding season).**

The methods used to classify goshawk habitat at multiple-spatial levels follows the architecture supported by the R1Multi-Level Classification, Mapping, Inventory, and Analysis System (Berglund et al. 2009). This system provides a consistent methodology to classify vegetation dominance type, tree size class, and tree canopy cover for R1-VMap and inventory data residing in FSVeg.

The scale and detail of analysis should be commensurate with the scale of the project. These considerations will reduce or eliminate the risks and threats to goshawks from human-based activities (see **Section 2.2.1**). These considerations are presented according to the research from which they originated and do not replace site-specific data and local knowledge of goshawk use in a project area.

Based on the research and conclusions presented in the preceding sections, goshawks are known to use a variety of habitat conditions in their home range. **The following considerations should be placed in context with the conditions specific to the project under analysis and the studies from which these considerations came. The original literature (summarized in the preceding sections) should be reviewed and referenced.**

**Considerations are presented at the project level. The Regional and Forest levels are referenced as a reminder to place project effects in context with the distribution of goshawks and their habitat in R1.**

## 3.2.1. Project Analysis Process

For all steps, document methodologies and assumptions.

### 3.2.1.1. Step One – Set the Regional Context

Establish the framework for assessing the distribution, status, and trend of goshawks Region-wide. Samson (2006a; Bush and Lundberg 2008) estimated that there is one population of goshawks across the Region. This provides context and background for discussing viability in the final effects determination.

Consider the following points (see also **Sections 1.3** and **3.1** above):

- The species is considered globally secure, and in Montana, the population is considered potentially at risk because of limited and/or declining numbers, range, and/or habitat, even

though it may be abundant in some areas and has a conservation status rank of S3 (MNHP 2009).

- The Service concluded "that the goshawk population is well distributed and stable at the broadest scale [63 FR 35183 (June 29, 1998)].
- Breeding goshawks and their habitat appear abundant and well-distributed across R1 (Kowalski 2006; Samson 2006a; updated in Bush and Lundberg 2008).
- Each National Forest appears to have more than enough habitat to maintain a minimum viable population (Samson 2006b).

#### 3.2.1.2. Step Two – Set the Forest Context

Compare the amount of nesting, PFA, and foraging habitat on the Forest to Samson's (2006b; Bush and Lundberg 2008) estimate of 30,147 acres needed for a minimum viable population in the entire Region (summarized in Table 4 above). This will aid in setting the context for addressing viability/sustainability across the planning area (Forest-wide) in the final determination.

#### 3.2.1.3. Step Three – Set the Home Range and Project Context

Set the framework for defining the analysis area and provide a basis for determining project and cumulative effects. Quantify the amount of nesting and foraging habitat in the analysis area and estimate the potential number of breeding pairs the analysis area can support.

1. **Define and delineate the analysis area**

   The analysis area should be well-defined, specify acres of Forest Service lands and other land ownership, encompass the affected area (which should be at least as large as the project area), and include sufficient area to contain **at least** one (approximately 5,000 acres) or more home ranges (defined in **Section 2.1.4**). Define and delineate the boundaries of the home range(s), considering watershed boundaries or other topographic features. Given the variety of habitat conditions across R1, a home range analysis could encompass one or more 6$^{th}$ field hydrologic unit codes (HUCs). For example, if the project falls within one 6$^{th}$ field HUC, 10,000 acres in size, then assume that the project analysis area contains two home ranges (assuming no overlap) based on available habitat.

   Define and document the methods and rationale used to delineate the analysis area. For example, "The analysis area for direct, indirect, and cumulative effects encompasses 15,000 acres of Forest Service lands located in the NoName 6$^{th}$ field HUC. The HUC was selected because it encompasses all proposed treatments that may affect goshawk habitat and is large enough to provide habitat for at least three goshawk home ranges (Kennedy 2003). A map of the analysis area is displayed in Appendix X."

2. **Conduct an analysis of foraging area habitat within the analysis area**

   Conduct an analysis of existing foraging area habitat using the best available vegetation information for the defined analysis area. Document the existing percent of total acres in

each of the vegetation life form/tree size classes displayed in Table 5. Refer to **Section 2.1.4, above,** for documentation as to why these life form/size classes were selected. Section 2(a) through (c), below, details a methodology for conducting the habitat analysis, using existing vegetation map products supported in R1, in GIS.

Once habitat is quantified and displayed, discuss and compare analysis area results to Reynolds et al. (1992) recommendations for foraging area components (at p. 7 in Table 1 of Reynolds et al. 1992**)**. **Note Reynolds et al. (1992) foraging area recommendations by structural stage class are identical to the PFA recommendations**, which are displayed in Table 3 of Section 2.1.4 above. Also discuss results specific to actual research conducted nearest to the geographic region. Refer to **Sections 2.1.3., 2.1.4.** (including Table 3 and associated footnotes), **2.2.1.,** and **2.2.2** [discussion of Reynolds et al. (1992)].

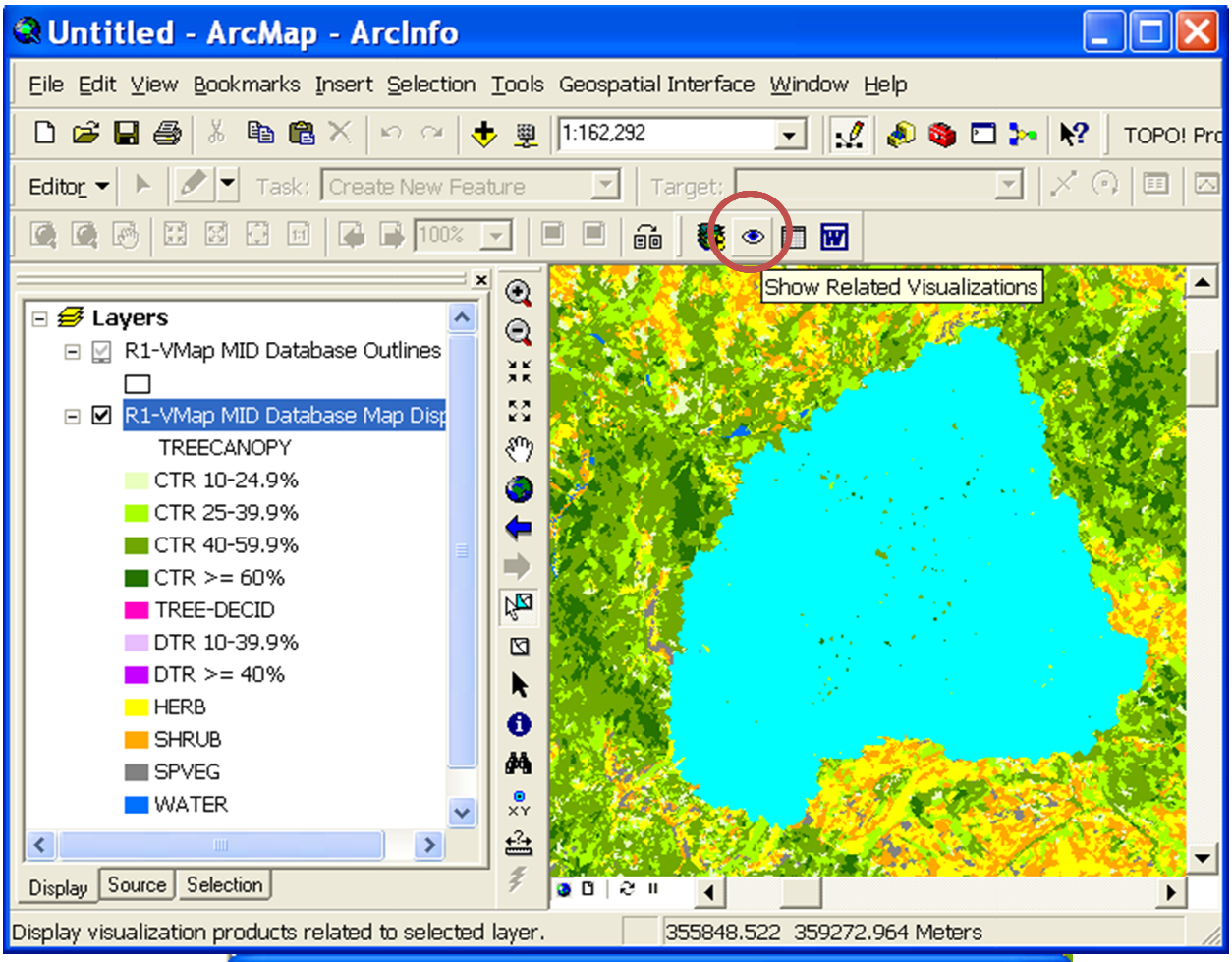
**Table 5. Home range/foraging area diversity matrix for habitat analysis.**

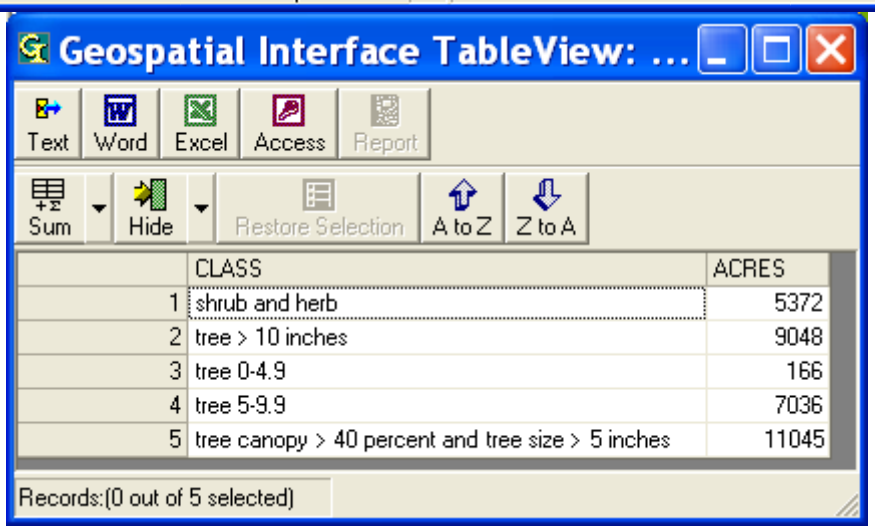
| Lifeform/VMap Tree Size Class (DBH)/Canopy Cover | Life form/SILC Tree Size Class (DBH)/Canopy Cover | % of Total Acres |
|---|---|---|
| Tree/0.0" – 4.9" | Tree/0.0" – 4.9" | |
| Tree/5.0" – 9.9" | Tree/5.0" – 8.9" | |
| Tree/10.0" plus | Tree/9.0" plus | |
| Canopy cover 40% + and size of 5.0" or larger | Canopy cover 40% + and size of 5.0" or larger | |
| Shrub/forb/grass | Shrub/forb/grass | |

**a) GIS analysis using VMap**

The R1-VMap data are registered for use in the NRIS Geospatial Interface (GI). A goshawk diversity matrix tool is also published in the GI to derive habitat estimates needed to populate Table 5. These VMap data are consistently derived across Forest Service administrative boundaries and often times will include private land. The accuracy of the VMap data can be inferred from the published accuracy for a larger geographic extent. However, unlike FIA data, no confidence limits for the estimate of habitat can be derived.

Within the GI, load your Forest's VMap Mid-level database and use ArcMap's *Select by Location* tool to select all VMap polygons within the analysis area. With the VMap Mid-level database layer highlighted in ArcMap's Table of Contents, select the *Show Related Visualizations* button from the GI toolbar. Run the *R1 Goshawk PFA/Home Range/Foraging Area Vegetation Diversity Matrix (FLQ)* tool to produce a table similar to table 5 above.




**b) Using stand exam data for habitat analysis and integrating with GIS information**

If stand exam data exists for polygons within that analysis area, that accurately represents existing vegetation on Forest Service lands within the delineated timber stand polygons, then those polygons can be integrated with the exiting vegetation (VMap) layer. This layer, and associated home range/foraging area diversity matrix, can be compiled by integrating stand

exam data from FSVeg with VMap information.

Stand exam data, within the home range area, can be run through the R1 FSVeg Web-based Reports to produce a Stand Exam Summary Database or a Stand Synopsis Report both of which provide stand acres (setting size), size class based on basal area weighted average diameter (size class), and canopy cover. These existing vegetation attributes are consistent with the classification used in R1-VMap allowing "hybrid" layers to be derived. For further information on the R1 FSVeg web-based reports, see the link and associated documentation at: http://fsweb.r1.fs.fed.us/forest/inv/fsveg/index.htm.

Note, FSVeg information can provide more detailed information and may be more accurate than the VMap labels for areas containing inventory information. Accuracy of a mixed VMap/FSVeg map products is unknown, but assumed to be better than the VMap, at least for the areas with stand exam data which represents current condition.

If TSMRS information exists that represents the current vegetation across the analysis area, home range analysis can be done with that information. However, TSMRS does not contain a canopy cover attribute and the attributes of size and forest type are not consistent with the R1 Vegetation Council existing vegetation classification used for R1 VMap. Note that the TSMRS information is often derived from a variety of methods, including walk-through and photo interpretation, the accuracy of which may vary across Districts and Forests. Furthermore, for some Forests/Districts, TSMRS information is not currently maintained or updated to represent current condition.

**c) Inventory analysis with intensified grid data**

If an intensified-grid inventory is available within the analysis area, estimates and confidence intervals of the home range/foraging diversity table can be derived using an Intensified Grid Summary Database.

Depending on the resolution of the grid data, estimates can be further stratified by dominance groups or by various spatial data sets to futher explore the data.

If intensified grid are remeasured over time, trends in home range/foraging diversity can be monitored over time.

**3. Conduct an analysis of nest area habitat in the analysis area**

Nesting habitat attributes displayed in this section are based on R1 POD stand data from Table 2 (in **Section 2.1.4.1,**) cross-walked to attributes available in R1-VMap **and displayed in Table 6, below**.

After quantifying and displaying the amount of suitable nesting habitat in the analysis area using the GIS analysis methods described below, place the results in context with the range of data found in the scientific literature relevant to the area (see **Section 2.1.4.1**). For example, Reynolds et al. (1992 at Table 1, p. 7) recommends maintaining 6 nest areas (3 suitable and 3 replacements), each at least 30 acres in size, totaling 180 acres per 5,000-acre

foraging area in the southwestern United States. In west-central Montana, Clough (2000) found nest areas averaged 40 acres in size. Thus, substituting 40 acres for 30 acres results in a conservative minimum of 240 acres of nest area per 5,000 acre home range.

**In addition, add a spatial component to the discussion on existing nesting habitat that addresses habitat fragmentation**. Refer to **Section 2.1.4.1** for examples.

### a) GIS analysis

**GIS analysis for nest area habitat is displayed in Table 6. In GIS, bring in the vegetation layer intersected with the analysis area. Quantify the number of acres in the analysis area that meet the tree dominance group, canopy cover, and tree size class indicated for the ecological province in Table 6. Stands should be at least 40 acres in size, a more conservative estimate than Reynolds et al. (1992), to qualify as nest habitat.**

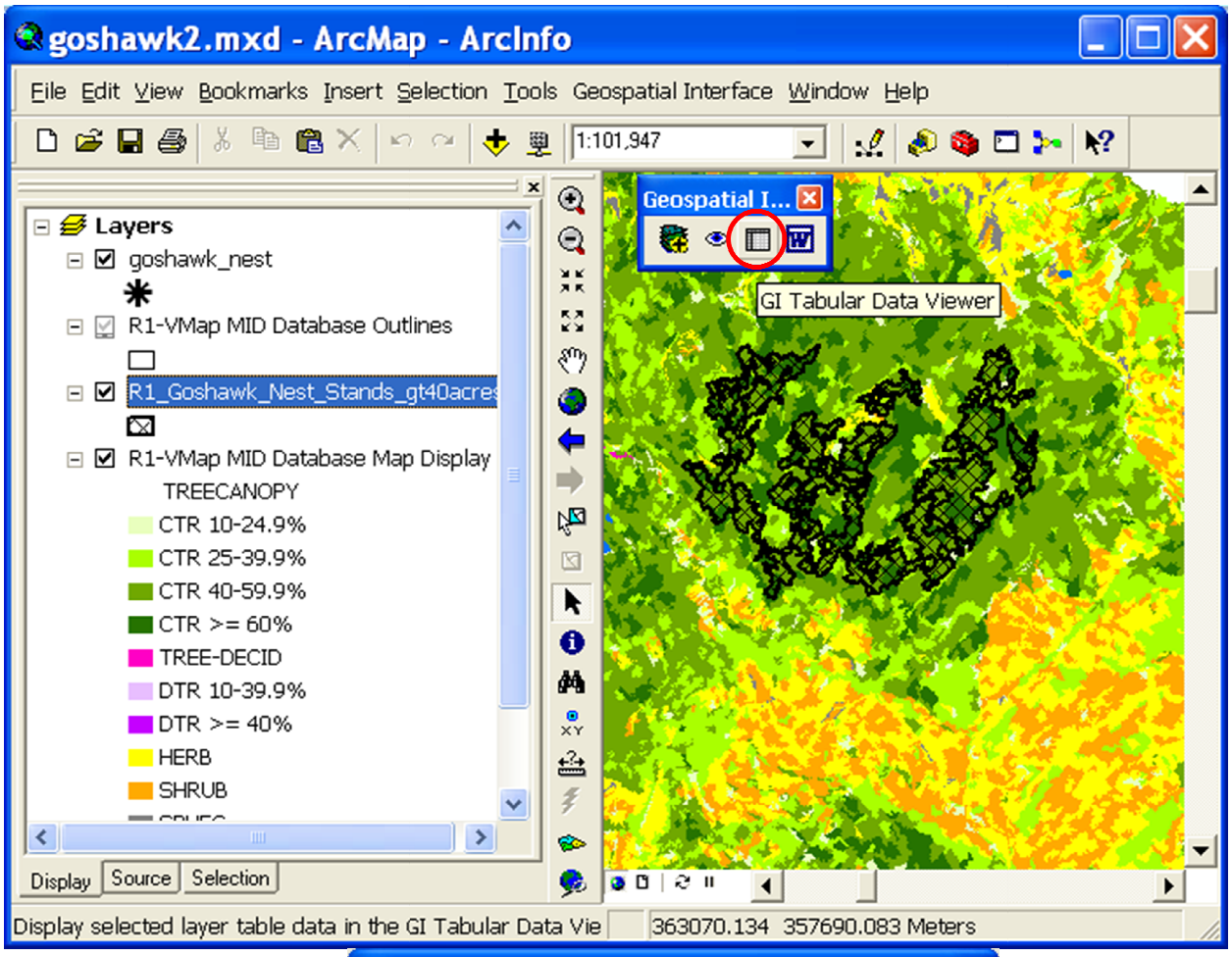
**Table 6. GIS goshawk nest stand attributes.**

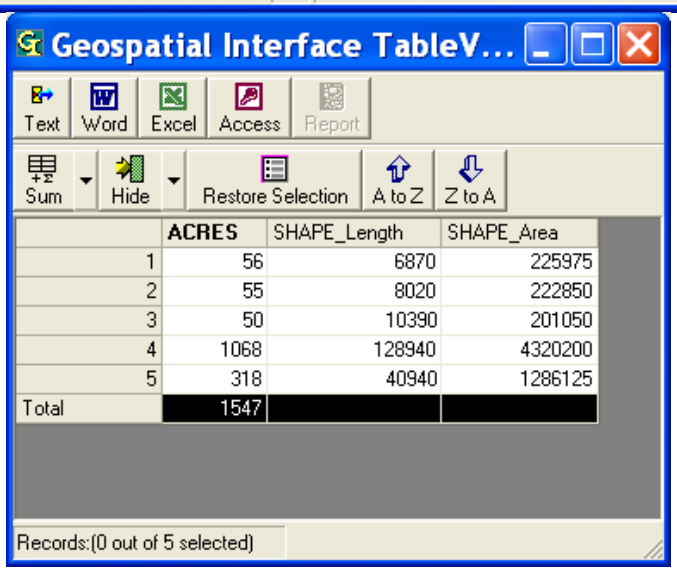
| Spatial Dataset | Ecological Province | Dominance Group | Canopy Cover | Tree Size Class |
|---|---|---|---|---|
| VMap | NRMEP: Idaho Panhandle, Clearwater, Flathead, Kootenai, Lolo | Grand fir, subalpine fir, lodgepole pine, intolerant mix, larch, western white pine, ponderosa pine, Douglas-fir, grand-fir/cedar/ western hemlock mix, subalpine fir/spruce/mountain hemlock mix | 40% + | 10.0" + |
| Lodgepole pine, Douglas-fir, ponderosa pine, intolerant mix | MRMEP: Beaverhead-Deerlodge, Bitte**rroot, Helena, Lewis & Clark, Nez Perce** | **Lodge**pole pine, Douglas-fir, ponderosa pine, intolerant mix | 40% + | 10.0" + |
| VMap | SRMEP: Custer, Gallatin | Douglas-fir, ponderosa pine, lodgepole pine, intolerant mix | 40% + | 10.0" + |

The R1-VMap data are registered for use in the NRIS Geospatial Interface (GI). A goshawk nest stand tool is also published in the GI to estimate the number of stands that meet the criteria in table 6. These VMap data are consistently derived across Forest Service administrative boundaries and oftentimes will include private land. The accuracy of the VMap data can be inferred from the published accuracy for a larger geographic extent. However, unlike FIA data, no confidence limits for the estimate of habitat can be derived.

Within the GI, load your Forest's VMap Mid-level database and use ArcMap's *Select by Location* tool to select all VMap polygons within the analysis area. With the VMap Mid-level database layer highlighted in ArcMap's Table of Contents, select the *Show Related Visualizations* button from the GI toolbar. Run the *R1 Goshawk Nest Stand for Middle and Southern Rocky Mountain Ecological Provinces (RSW)* tool (or *Northern* or *Middle* as

appropriate)to produce a feature class of VMap stands that meet nesting habitat criteria. With the new feature class (R1_Goshawk_Nest_Stands_gt40acres) highlighted inArcMap's table of contents, select the table viewer from the GI toolbar. Use the SUM function to calculate total acres of potential nest stand habitat within the analysis area.



**b) Using stand exam data for habitat analysis and integrating with GIS information. If stand exam data is available for timber stand polygons within the analysis area which accurately represents existing vegetation, then those polybons can be merged with VMap within the analysis area.**

Stand exam data within the nest habitat area can be run through the R1 FSVeg Web-based Reports to produce a Stand Exam Summary Database or a Stand Synopsis Report both of which provide stand acres (setting size), size class based on basal area weighted average diameter (size class), and canopy cover. These existing vegetation attributes are consistent with the classification used in R1-VMap allowing "hybrid" coverages to be derived. For further information on the R1 FSVeg web-based reports, see the link and associated documentation at: http://fsweb.r1.fs.fed.us/forest/inv/fsveg/index.htm.

Note, FSVeg information can provide more detailed information and may be more accurate than the VMap labels for areas containing inventory information. Accuracy of a mixed VMap/FSVeg map products is unknown, but assumed to be better than the VMap, at least for the areas with stand exam data which represents current condition.

If TSMRS information exists that represents the current vegetation across the analysis area, nest stand analysis can be done with that information. However, TSMRS does not display canopy cover. TSMRS size class is based on QMD whereas Table 6 is based on basal area weighted average diameter. TSMRS forest type is based on plurality whereas dominance group is displayed in table 6 base on R1 Vegetation Council existing vegetation classification. Note that the TSMRS information is often derived from a variety of methods, including photo interpretation, the accuracy of which may vary across Districts and Forests. Furthermore, for some Forests/Districts, TSMRS information is not currently maintained or updated to represent current condition.

**c) Inventory analysis with intensified grid data**

If an intensified-grid inventory is available within the analysis area, estimates and confidence intervals of the nest area habitat can be derived using an Intensified Grid Summary Database based on the attributes displayed in Table 6. Depending on the resolution of the grid data, estimates can be further stratified by dominance groups or by various spatial data sets to futher explore the data. If intensified grid data are remeasured over time, trends in nest area habitat can be monitored over time.

**4. Conduct a PFA habitat analysis**

Conduct an analysis of PFA habitat on known or recently-occupied nests (see glossary for definition of recently-occupied) that occur within the analysis area using the best available vegetation information. Document the existing percent of total acres in each of the vegetation life form/tree size classes displayed in Table 7. Refer to **Section 2.1.4, above,** for documentation as to why these life form/size classes were selected. Section 4(a) through (c),

below, details a methodology for conducting the PFA habitat analysis in GIS. Procedures are consistent with the foraging area analysis above.

Once PFA habitat is quantified and displayed, discuss and compare results to Reynolds et al. (1992) recommendations for PFA habitat components (at p. 7 in Table 1 of Reynolds et al. 1992**) (**also refer to Section 2.1.4 and Table 3). Incorporate discussion of results specific to the range of habitat components found in actual PFA research nearest your geographic region. Refer to **Section 2.1.4.3**, especially Table 3 and associated footnotes for other research, and **Section 2.2.1**. for a discussion of Reynolds et al. (1992). Post-treatment, the amount of high canopy cover left in the PFA should fall within the ranges exhibited in Table 3, recognizing that managing at the lower end of the range is not supported by research specific to the Northern Region.

**Table 7. PFA diversity matrix for habitat analysis.**

| VMap Lifeform/ Tree Size Class (DBH)/Tree Canopy Cover Class | % of Total Acres |
|---|---|
| Tree/0.0" – 4.9" | |
| Tree/5.0" – 9.9" | |
| Tree/10.0" plus | |
| Canopy cover 40% + and size of 5.0" or larger | |
| Shrub/herb | |

**a) GIS analysis**

**The PFA analysis can be done in the same manner as the home range and foraging area analysis described in Section 2.a. using the *R1 Goshawk PFA/Home Range/Foraging Area Vegetation Diversity Matrix (FLQ)* Geospatial Interface tool. The user can import a nest location and use the *Select by Location* tool in ArcMap to select all VMap polygons within 2000 feet (610 meters) of the nest site. Or, the user may import another polygon feature that would encompass approximately 420 acres (Section 2.1.4.3) and use the *Select by Location* tool with that polygon feature.**

**b) Using stand exam data for habitat analysis and updating GIS information**

**All methodologies described in 2 (b) above apply except the words "foraging area" are replaced by "PFA."**

**c) Inventory analysis with intensified grid data**

**All methodologies described in 2 (b) above apply except the words "foraging area" are replaced by "PFA."**

## Section 3.2.1.4. Step 4 – Set the Treatment Context

The following provides a list of considerations to address project effects on goshawks.

a) **Treatment acres in the foraging area, potential nesting areas, and in recently occupied PFAs**

Display the change in acres post-treatment for each of the vegetation attributes in Table 5 (foraging area), Table 6 (nesting habitat), and Table 7 (PFA habitat). This can be done in the

direct effects section by adding a "Post-treatment % of total acres" column at the end of each table, along with a qualitative discussion.

b) **Nesting habitat in the foraging area**
Maintain at least 240 acres of nesting habitat per 5000-acre foraging area in stands of at least 40 acres. For example, if the analysis area encompasses a 10,000- acre 6th field HUC, or approximately two goshawk home ranges, maintain 480 acres of nesting habitat. Refer to **Section 2.1.4.1**.

c) **Nest area no activity buffer for known occupied sites that will be protected**
At recently occupied goshawk nests (defined in glossary), maintain a minimum 40-acre no activity buffer around nest trees to maintain existing conditions in the nest stand. Recall, the actual shape and size of the buffer may vary based on the size of the nest stand, topography, or other local conditions. Refer to **Sections 2.1.4.1.** and **2.1.4.2**. No activity means no ground disturbing activities may occur in known occupied nest stands at any time during the year until the nest stand is no longer occupied (**refer to glossary for definition occupied**).

d) Activity timing in PFAs
Allow no ground disturbing activities inside known occupied PFAs from April 15 through no sooner than August 15 to protect the goshawk pair and young from disturbance during the breeding season until fledglings are capable of sustained flight. Note, fledglings are not capable of sustained flight until flight feathers fully develop and harden, which takes 30 days after fledging off the nest. After at least August 15, treatment-related activities may commence within the PFA, but outside the nest area, unless site-specific monitoring supports earlier or later entry.

e) **Direct, indirect, and cumulative effects**
Discuss direct, indirect, and cumulative effects of the project on goshawk considering the treatment context [Step 4(a) through (d) above] with the foraging area and project context (Step 3, 1 through 4 above), including the discussion points under Step 3, number 2, second paragraph; Step 3, second and third paragraphs; and Step 4, second paragraph. Be sure to cite the original research rather than this document by itself.

There are tools that are supported by the Region to assist with cumulative effects analysis. Within the project area, various treatment scenarios can be modeled using the Forest Vegetation Simulator (FVS) and intensified grid data or representative stand data. The Region 1 Existing Vegetation Classification Program (Bush and others, 2009) can be run against FVS treelist data to compare changes in dominance group, size class, vertical structure, and canopy cover over time. Biologists are encouraged to work with silviculturists if this type of modeling would be useful.

Answering the following questions may aid in determining effects:

- Is there a potential for project activities to disturb or displace goshawks during the nesting period? If 1 (b), (c), and (d) above are applied to known or newly discovered

nests, the potential for direct disturbance will be low. If not, refer to risk factors and relevant research summarized in **Section 2.2.1.3**.

- Will the project increase/decrease the amount and suitability of nesting, PFA, or foraging area habitat? How do the pre- and post-project implementation amounts compare to Reynolds et al. (1992) recommendations as well as to the ranges of habitat conditions found in actual research relevant to the conditions in the project analysis area?
- Will the action provide for adequate amounts of nesting habitat to support the estimated number of breeding pairs? If Steps 4 (b) through (d) above are applied, the answer is probably yes.
- Will the project fragment suitable nest areas? Or known occupied PFAs (i.e., see Step 3, number 3, third paragraph above)?
- If so, is there a potential for increasing the risk of predation or competition from more open-forested species (i.e., see **Sections 2.1.8, 2.1.9**)?
- Will the project increase habitat diversity for prey populations in the PFA and foraging area (i.e., see **Sections 2.1.3, 2.1.4** (introductory paragraph), **2.1.4.3, 2.1.4.4**, and **2.2.1.2**)?
- Have or will past, present, and reasonably foreseeable activities affected the amount and suitability of goshawk nesting and foraging habitat? If so, how? For example, "500 acres of vegetation treatments have occurred in mature Douglas-fir dominance types in the past 10 years. Remaining canopy covers are consistent with where goshawks generally nest and forage in this area **(*provide citations*).**" How do project and cumulative effects relate to available habitats across the Forest and Region?

**Section 3.2.1.5. Step 5 – Conclusions**

Make a final determination for impacts and list the rationale for the determination. For example, the project may impact individual goshawks or goshawk habitat but is not expected to contribute to a loss of viability or a trend towards federal listing for the population or species because: nesting goshawks will be adequately protected through activity timing restrictions, occupied nest areas will be conserved (eliminated from treatment), PFA and foraging area habitat are consistent with Reynolds et al. (1992) recommendations and/or actual research relevant to the analysis area, adequate nesting habitat will remain in the analysis area to support the estimated breeding pairs, habitat Forest-wide is abundant and widely distributed, etc.

## 3.2.2. Stand Exam Protocols for Assessing Goshawk Habitat

If additional stand-level information is needed to assist with assessing various habitat needs of goshawk, Common Stand Exam protocols are available to ensure that all necessary attributes are collected. See http://fsweb.r1.fs.fed.us/forest/inv/cse_exams/cse_template.htm for template files or contact the R1 field protocol specialist.

## Appendix A: Glossary

**Active nest:** A goshawk nest known to have contained an egg. A nest need not have successfully produced fledglings to be considered active.

**Active nest area:** An alternate nest area can be a nest area that has been recently active or historical within the last 5 to 8 years. When historical nest areas cannot be located, designated alternates will contain the habitat attributes that would commonly occur in an active nest area.

**Activity area:** A land area impacted by a management activity, excluding specified transportation facilities, dedicated trails, and mining excavations and dumps. "Activity area" can also mean the smallest logical land area where the effect that is being analyzed or monitored is expected to occur. The area may vary in size depending on the effect that is being analyzed or monitored, because some effects are quite localized and some occur across landscapes. Activity areas are to be specifically described when used in planning and project implementation documents.

Activity areas include harvest units within timber sales, prescribed burn areas, and grazing areas within allotments. Riparian and other environmentally sensitive areas may be monitored and evaluated as individual activity areas within larger management areas.

**Alternative nest area:** Goshawk home ranges often contain two or more nest areas, only one of which will be active in a given year.

**Basal Area (BA):** Basal area is the cross section at breast height (4.5 feet above ground level) or at the root crown of a tree or trees, usually expressed as square feet per acre. Basal area is a measure of stand density.

**Breeding season:** The period from mid-April through mid-August which includes courtship and egglaying through , incubation, nestling, and fledgling-dependency periods (Kenward et al. 1993, Reynolds et al. 1994, Tyack et al. 1998, Kennedy and Ward 2003, Moser and Garton 2009**).** .

**Canopy cover:** The percentage of ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants. Small openings within the canopy are included. See Federal Geographic Data Committee—Vegetation Subcommittee, FGDC-STD-005 National Vegetation Classification Standard Version 2 – Working Draft, November 30, 2006.

**Canopy closure:** Canopy cover and canopy closure are not synonymous in the Region. Canopy closure is the proportion of the sky hemisphere obscured by vegetation when viewed from a single point on the ground**.** To date, no consistent method of measurement has emerged as the norm but include moosehorn and spherical densiometer.

**Conifer:** A tree that produces cones, such as a pine, spruce, or fir tree.

**Connectivity:** Pertaining to the extent to which conditions exist or should be provided between separate areas to ensure habitat for breeding, feeding, or movement of wildlife and fish within their home range or migration areas.

**Cover:** Vegetation used by wildlife for protection from predators, breeding and rearing of young (hiding cover), or to ameliorate weather conditions.

**Cover type:** The current or existing vegetation of an area, based on the predominant vegetation species.

**Cumulative effects:** The effects on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

**Cumulative Effects Area:** The extent of an area in which direct, indirect and indirect effects of management actions can be detected.

**Desired Future Condition (DFC):** A portrayal of the land, resource, or social and economic conditions that are expected to result in 50-100 years if objectives are achieved; a vision of the long-term conditions of the land.

**Diameter at breast height (DBH):** The outside bark diameter of a tree measured at breast height, 4.5 feet above the forest floor on the uphill side of the tree.

**Disturbance:** Any event, such as wildfire or a timber sale that alters the structure, composition, or function of an ecosystem.

**Disturbance regime:** All known current and historical disturbances within an analysis area. Typically related to fire and/or hydrological processes.

**Dominant tree:** The tallest tree in a forest. Together with the co-dominants, the dominant trees comprise the main canopy of the stand.

**Down wood:** Any piece(s) of dead woody material, e.g., dead logs, boles, limbs, and large root masses, on the ground in forest stands or in streams.

**Effects:** The environmental consequences of a proposed action. Included are Direct effects, which are caused by the action and occur at the same time and place; and indirect effects, which are caused by the action and are later in time or further removed in distance, but which are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and are related effects on air, water and other natural systems, including ecosystems.

**Failed nest:** An active nest in which the eggs or nestlings are lost (e.g., to predators, weather) or abandoned by the adult(s). No young are fledged.

**Fledgling:** A young bird that has left the nest but is unable to completely care for itself.

**Fledgling-dependency period:** The period beginning when the young leave the nest to when they are no longer dependent upon adults for food.

**Foraging habitat:** Areas where prey are searched for, pursued by and captured by goshawks.

**Forest cover type:** A category of forest usually defined by its vegetation, particularly its dominant vegetation as based on percentage cover of trees, e.g., spruce-fir, aspen, Douglas-fir.

**Forested area:** One capable of supporting >10% canopy cover under the natural disturbance regime and within the historic range of variation.

**Fragmentation:** The splitting or isolating of patches of similar habitat, typically forest cover, but including other types of habitat. Habitat can be fragmented naturally or from forest management activities.

**Habitat:** The place (including climate, food, cover, and water) where an animal, plant or population naturally or normally lives and develops.

**Historical nest:** An intact nest known to have been active more than 5 to 8 years from the present time.

**Historical nest area:** A nest area containing one or more historical nests. An alternate nest area can be a historical nest area.

**Home range:** The area that an animal habitually uses during nesting, resting, bathing, foraging and roosting. Adjacent pairs of goshawks may have overlapping home ranges, the extent of which is typically unknown. A nesting home range contains nest areas (active and historical), the post fledgling area, and the surrounding foraging habitat.

**HUC:** Hydrologic Unit Code. A standardized hierarchical classification scheme in which the lower 48 states are divided into 18 regions and each region is further subdivided resulting in a unique number for each watershed. A 5th order HUC ranges from 40,000 to 250,000 acres (60 to 400 square miles). A $6^{th}$ order HUC ranges from 10,000 to 40,000 acres (15 to 60 square miles).

**Landscape:** A large land area composed of interacting ecosystems that are repeated due to factors such as geology, soils, climate, and human impacts. Landscapes are often used for course grain analysis.

**Mature forest:** Sometimes referred to as mature sawtimber in R1**.** Includes tree size classes of > 9.9 or > 10.0 inches in diameter at breast height.

**Mid-aged forest:** **S**ometimes referred to or used synonymously with the term pole-timber or pole-sized trees. In R1, includes stand tree size classes of 5.0 to 9.9 or 5.0 to 8.9 inches diameter at breast height.

**Multi-storied stand:** A forest stand having more than one horizontal vertical layer of vegetation. In R1, vertical structure is calculated according to R1 Vegetation Council existing vegetation classification algorithms (Barber et al. 2009).

**Nest:** A platform of sticks on which eggs are laid. Most goshawk nests are placed within the lower two-thirds of tree crowns, often against the trunk but occasionally on a limb up to 10 feet from the trunk.

**Nest area:** The nest tree and stand(s) surrounding the nest that contain prey handling areas, perches, and roosts. Nest areas are often on cool and mesic sites (northerly facing slopes).

**Nest stand:** The stand of trees that contains the nest tree.

**Nest tree:** The tree containing the nest.

**Nesting season:** The period from the beginning of courtship behavior (approximately mid-April) until the fledgling(s) have refined flying skills and are no longer dependent on adults for food. This occurs once flight feathers harden and fledglings are capable of sustained flight (one-month post-fledging (around mid-August).

**Occupied or Recently Occupied:** Refers to the use of a nest area, PFA, or home range by a breeding pair of goshawks and its young during the breeding season. Note that determining non-use of an area where a breeding pair has been previously documented may require monitoring the area for occupancy during the breeding season over a 5-year (Woodbridge and Hargis 2006) to 8-year period (Reynolds et al. 2007).

**Old forest:** Usually the latest successional stage of forest development.

1. Generally, structural characteristics used to describe include (a) live trees: number and minimum size of both seral and climax dominants, (b) canopy conditions: commonly including multi-layering, (c) snags: minimum number of specific size, and (d) down logs and course woody debris: minimum tonnage and numbers of pieces of specific size;
2. Generally contain trees that are large for their species and site and sometimes decadent (overmature) with broken tops, often a variety of tree sizes, large snags and logs, and a developed and often patchy understory;
3. Stand age, although a useful indicator of old growth, is often considered less important than structure because (a) the rate of stand development depends more on environment and stand history than age alone, and (b) dominants are often multi-aged;
4. Due to large differences in forest types, climate, site, quality, and natural disturbance history (e.g., fire, wind, and disease and insect epidemics), vary extensively in tree size, age classes, presence and abundance of structural elements, stability, and presence of understory;

5. Minimum area needed to be a functional ecological unit depends on the nature and management of surrounding areas; small areas often do not contain all old-growth elements;
6. Commonly perceived as an uncut, virgin forest with very little human-caused disturbance; some believe that the time taken for stands to develop old-growth structure can be shortened by silvicultural treatments aimed at producing the above characteristics.

**Overstory:** In a forest with multiple layers of vegetation, the portion of the trees forming the uppermost (canopy) layer.

**Post-fledging area:** The area of concentrated use by the goshawk family after the young leave the nest.

**Recently-occupied: See "Occupied" above.**

**Replacement nest area:** Forest areas with physiographic characteristics and size(s) similar to suitable nest areas. Replacement areas can have young to mature forests that can develop into suitable nest areas.

**Roost:** Trees or groups of trees used by birds or mammals for resting. A roost site consists of all other trees whose crowns overlap or interlock with the roost tree.

**Seral species:** A plant or animal species that will be replaced over time through forest succession.

**Seral stage** (may also be referred to as **successional stage**): Any stage of development of an ecosystem from a disturbed, unvegetated state to a climax plant community. Forest seral stages are often referred to as early, mid, or late dependent upon the mix of species present and/or the conditions of the stand. Early seral stages are normally dominated by shade intolerant species, and late seral stands by shade-tolerant species, with mid-seral stands in transition. In systems where a single tree species dominates, such as lodgepole pine or aspen, forest seral stages are more commonly equated to vegetative structural stages. Concurrent with a change in overstory composition as forests move from early to mid to late seral stages, is a change in understory species. With early seral stands typically containing shade intolerant ground plants and late seral stands typically containing more shade tolerant ground species.

**Single-storied stand:** A stand of trees having a single canopy layer.

**Size class:** A classification of the size of trees in a stand. R1 currently uses a basal area weighted average diameter to calculate size and puts the result into 5-inch wide diameter classes.

**Snag:** A standing dead tree.

**Stand:** A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality to be a distinguishable unit.

**Structure:** The horizontal and vertical arrangement of ecosystem components. Vegetation patches, edge, canopy layers, snags, down wood, steep canyons, rocks in streams, and roads may be arranged in some pattern or mosaic, or the structure may totally random.

**Succession:** The gradual replacement in time of one plant community with another. The prior plant community (or successional stage) creates conditions that are favorable for the establishment of the next stage.

**Successful nest:** A nest from which at least one young is fledged.

**Suitable habitat:** Habitat that is currently useable for nesting, roosting and foraging. Habitat need not be occupied to be considered suitable.

**Suitable nest area:** An area that includes all the attributes of a nest area and is, therefore, useable for nesting.

**Territory:** An exclusive area defended by goshawks. An active nest is not an essential element of a territory.

**Understory:** Any layer of the forest canopy below the overstory; can consist of trees, shrubs and/or herbaceous layers.

**Unsuitable habitat:** Habitat that does not have the capability of attaining the characteristics of suitable habitat through standard, prescribed management treatments or natural processes.

**Young forest:** Sometimes referred to as seedling/saplings. In R1, includes stand tree size classes of 0.1 to 4.9 inches diameter at breast height.

## Appendix B: Literature Cited


Allendorf, F.W., and N. Ryman. 2002. The role of genetics in population viability analysis. Pages 50-85 *in* Population Viability Analysis. S.R. Beissinger, and D.R. McCullough, editors. University of Chicago Press, Chicago, Illinois, USA.

Andersen, D. E., S. E. DeStefano, M. I. Goldstein, K. Titus, C. Crocker-Bedford, J. J. Keane, R. G. Anthony, and R. N. Rosenfield. 2005. Technical review of the status of northern goshawks in the western United States. Journal of Raptor Research 39:192-209.

Babbitt, C., Galvin, P., Hitt, S. M., Hoffman, S. W., MacFarlane, A., Rait, K., Sandell, C. I., Sauber, M., Schulke, M. T. and G. Wardwell. 1991. Letter to the US Dept. of the Interior, requesting to amend a petition to list the northern goshawk. Maricopa Audubon Society. Phoenix, Arizona. September 26, 1991. 5 pp.

Bailey, R. G. 1996. Ecosystem geography. Springer-Verlag, New York, New York, USA.

Barber, J., D. Berglund, and R. Bush. 2009. The region 1 existing vegetation classification system and its relationship to inventory data and the region 1 existing vegetation map products. Region 1 Vegetation, Classification, Inventory, and Analysis Report # 09-03 5.0. http://fsweb.r1.fs.fed.us/forest/inv/classify/r1_ex_veg_cmi_4_09.pdf

Bechard, Marc J., G. D. Fairhurst, and G. S. Kaltenecker. 2006. Occupancy, productivity, turnover, and dispersal of northern goshawks in portions of the northeastern Great Basin. Studies in Avian Biology No. 31: 100-108.

Beier, P., and J. E. Drennen. 1997. Forest structure and prey abundance in foraging areas of northern goshawks. Ecological Applications 7: 564-571.

Beier, P., E. C. Rogan, M. F. Ingraldi, S. S. Rosenstock. 2008. Does forest structure affect reproduction of northern goshawks in ponderosa pine forests? Journal of Applied Ecology 45:342-350.

Berglund, D., R. Bush, J. Barber, and M. Manning. 2009. R1 multi-level vegetation classification, mapping, inventory, and analysis wystem. Region One Vegetation Classification, Mapping, Inventory, and Analysis Report #09-01 2.0. http://fsweb.r1.fs.fed.us/forest/inv/classify/cmia_r1_2_09.pdf

Boal, C.W. 1994 and R.W. Mannan. 1994. Northern goshawk diets in ponderosa pine forests on the Kaibab Plateau. Stud. Avian Biol. 16:97-102.

Boal, C.W., D.E. Andersen, and P.L. Kennedy. 2005. Foraging and nesting habitat of Northern Goshawks breeding in the Laurentian mixed forest province, Minnesota. Journal of Wildlife Management 69:1516-1527.

Bowman, J. 2003. Is dispersal distance of birds proportional to territory size? Canadian Journal of Zoology 81: 195-202.

Bright-Smith, D. J., and R.W. Mannan. 1994. Habitat use by breeding male northern goshawks in northern Arizona. Studies in Avian Biology 16: 58-65.

Brohman, R; Bryant, L. eds. 2005. Existing Vegetation Classification and Mapping Technical Guide. Gen Tech. Rep. WO-67. Washington, DC: U.S. Department of Agriculture Forest Service, Ecosystem management Coordination Staff.

Berglund, Doug, R. Bush, R. Lundberg. Region 1 Vegetation Classification Algorithms for Forested Vegetation. September, 2005. http://fsweb.r1.fs.fed.us/forest/inv/classify/index.htm

Bush, R., D. Berglund, A. Leach, R. Lundberg, J.D. Zeiler. Overview of R1-FIA Summary Database, Region 1 Vegetation Classification, Inventory, and Analysis Report #06-02, 2006. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/r1_sum_db.htm.

Bush, R., D. Berglund, R. Lundberg, A. Zack. Estimates of Old Growth and Snag Densities for the Idaho Panhandle National Forest, Region 1 Vegetation Classification, Inventory, and Analysis Report #06-07, 2006. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/analysis.htm.

Bush, R. and R. Lundberg, 2008. Wildlife Habitat Estimate Updates for the Region 1 Habitat Conservation Assessment, Region One Vegetation Classification , Mapping, Inventory, and Analysis Report 08-04 1.0. http://fsweb.r1.fs.fed.us/forest/inv/fia_data/cons_asses_hab_estimates.pdf

Bush, R., R. Lundberg, and J.D. Zeiler. 2009. Region 1 existing vegetation classification program. Region One Vegetation Classification , Mapping, Inventory, and Analysis Report #09-07 2.0. http://fsweb.r1.fs.fed.us/forest/inv/classify/index.htm

Canfield, J.E. 2006. Vegetation analysis of goshawk detections and nests from the 2005 survey of Northern Region forests. Report to R1, Missoula, Montana.

Clough, L. T. 2000. Nesting habitat selection and productivity of northern goshawks in west-central Montana. Missoula, MT: University of Montana. M.S. Thesis. 87 pp.

Crocker-Bedford, D.C. 1990. Goshawk reproduction and forest management. Wildlife Society Bulletin. 18: 262-269.

Crocker-Bedford, D.C. and B. Chaney. 1988. Characteristics of goshawk nesting stands. In:R.L. Glinski et al., eds. Proceedings of the 1983 Technical Session of the Wildlife and Fish Ecology Working Group of the Society for American Foresters, Washington, D.C.

DeSimone, S.M. 1997. Occupancy rates and habitat relationships of Northern Goshawks in historical nesting areas in Oregon. Master's thesis, Oregon State University, Corvallis, OR.

DeSimone, S. M. and S. DeStefano. 2005. Temporal patterns of northern goshawk nest area occupancy and habitat: a retrospective analysis. Journal of Raptor Research 39:310-323.

Doyle, F. I., and J. N. Smith. 1994. Population responses of northern goshawks to the 10-year cycle in numbers of snowshoe hares. Studies in Avian Biology 16:122-129.

Fairhurst, G. D. and M. J. Bechard. 2005. Relationships between winter and spring weather and northern goshawk (Accipiter gentilis) reproduction in northern Arizona. Journal of Raptor Research 39:229-236.

Fahrig, L. 1997. Relative effects of habitat loss and fragmentation on species extinction. Journal of Wildlife Management 61: 603-610.

Finn, S.P., D.E. Varland, and J.M. Marzluff. 2002. Does Northern Goshawk breeding occupancy vary with nest-stand characteristics on the Olympic Peninsula, Washington? Journal of Raptor Research 36:265-279.

Flather, C. H., and M. Bever. 2003. Patchy reaction-diffusion and population abundance: the relative importance of habitat amount and arrangement. American Naturalist 159: 40-56.

Gallant, A., A. J. Hansen, J. S. Councilman, D. K. Monte, and D. W. Betz. 2003. Vegetation dynamics under fire exclusion and logging in a Rocky Mountain watershed. Ecological Applications 13: 385-403.

Gatto, A. E., T. G. Grubb, and C. L. Chambers. 2005. Red-tailed hawk dietary overlap with northern goshawks on the Kaibab Plateau, Arizona. Journal of Raptor Research 39:439-444.

Graham, R.T., T.B. Jain, R.T. Reynolds, and D.A. Boyce. 1997. The role of fire in sustaining Northern Goshawk habitat in Rocky Mountain forests. Proceedings: fire effects on rare and endangered species and habitat conference. 13-16 Nov. 1995, Couer'd Alene, ID.

Graham, R.T., R.L. Rodgriguez, K.M. Paulin, R.L. Player, A.P. Heap, R. Williams. 1999. The northern goshawk in Utah: Habitat assessment and management recommendations. USDA Forest Service. Rocky Mountain Research Station. RMRS-GTR-22. 48pp.

Greenwald, D.N., D.C. Crocker-Bedford, L. Broberg, K.F. Suckling, and T. Tibbitts. 2005. A review of Northern Goshawk habitat selection in the home range and implications for forest management in the western United States. Wildlife Society Bulletin 33:120-129.

Hargis, C. D., McCarthy, C. and R. D. Perloff. 1994. Home ranges and habitats of northern goshawks in eastern California. Studies in Avian Biology. 16: 66-74.

Hasselbad, K. and M. Bechard. 2007. Male northern goshawk home ranges in the Great Basin of south-central Idaho. Journal of Raptor Research 41:150-155.

Hessburg, P. F., and J. K. Agee. 2003. An environmental narrative of inland northwest United States Forest. Forest Ecology and Management 178: 23-59.

Hessburg, P. F., J. K. Agee, and J. F. Franklin. 2004. Dry forests and wildlife fires in the inland Northwest USA: contrasting landscape ecology of the pre-settlement and modern eras. Forest Ecology and Management. In press.

Hoffman [eds.] Proceedings of the southwest raptor management symposium and workshop, 21-24 May 1986, Univ. of Arizona, Tucson. National Wildlife Federation, Washington, DC, National Wildlife Federation Scientific and Technical Series No. 11. 210-217 pp.

IUCN (International Union for the Conservation of nature and Natural Resources). 1980. World conservation strategy: living resource conservation for sustainable development. IUCN-UNEP-WWF, Gland, Switzerland.

Jansson, G., and P. Angelstam. 1999. Threshold levels of habitat composition for the presence of the long-tailed tit (*Aegithalos caudatus*) in a boreal landscape. Landscape Ecology 14: 283-290.

Joy, S. M. 2002. Northern goshawk habitat on the Kaibab National Forest in Arizona: factors affecting nest locations and territorial quality. Dissertation, Colorado State University, Fort Collins, Colorado, USA.

Keane, John J., M. L. Morrison and D. M. Fry. 2006. Prey and weather factors associated with temporal variation in northern goshawk reproduction in the Sierra Nevada, California. Studies in Avian Biology No. 31: 85-99.

Kennedy, P.L., J.M. Ward, G.A. Rinker, and J.A. Gessaman. 1994. Post fledgling family areas in Northern Goshawk home ranges. Stud. Avian Biol. 16:75-82.Kennedy, P. L. 2003. Northern goshawk (*Accipiter gentilis atricapillus*): a technical conservation assessment. Unpublished report, USDA Forest Service, Rocky Mountain Region, Species Conservation Project, Denver, Colorado, USA.

Kennedy, P.L., and J.M. Ward. 2003. Effects of experimental food supplementation on movements of juvenile Northern Goshawks (*Accipiter gentiles atricapillus*). Oecologia 134:284-291.

Kennedy, P.L. 2003. Northern Goshawk conservation assessment for Region 2, USDA Forest Service. http://www.fs.fed.us/r2/projects/scp/assessments/northerngoshawk.pdf (27 September 2005).

Kennedy, P. L. 1997. The northern goshawk (*Accipiter gentilis atricapillus*): is there evidence of a population decline. Raptor Research 31:95-106.

Kenward, R.E., Marcstrom, V. and M. Karlbom. 1993. Post-nesting behavior in goshawks, *Accipiter gentilis*: I. The causes of dispersal. Animal Behavior. 46: 365-370.

Kimball, A.R. 2004. Northern Region Sensitive Species list. http://fsweb.r1.fs.fed.us/wildlife/wwfrp/TESnew.htm October 28, 2004.

Koenig, W. D., P. N. Hooge, M. T. Stanback, and J. Haydock. 2000. Natal dispersal in the cooperatively breeding acorn woodpecker. Condor 102: 492-502.

Kowalski, S. 2006. Frequency of northern goshawk presence in R1. Unpublished report on file in USDA For. Serv., Region One, Missoula MT. (to be added to http://www.fs.fed.us/biology/ wildecology/goshawk.html)

La Sorte, F.A., R.W. Mannan, R.T. Reynolds, and T.G. Grubb. 2004. Habitat associations of sympatric red-tailed hawks and northern goshawks on the Kaibab Plateau. Journal of Wildlife Management 68: 307-317.

Mahon, T. and F.I. Doyle. 2005. Effects of timber harvesting near nest sites on the reproductive success of northern goshawks (Accipiter gentilis). Journal of Raptor Research 39:335-341.

Maj, M. 1996. Draft summary of goshawk information from the Forest Service Northern Region. 32 pp. Page 18.

McGrath, M. T., S. DeStefano, R. A. Riggs, L. L. Irwin, and G. J. Roloff. 2003. Spatially explicit influences on Northern Goshawk nesting habitat in the interior Pacific Northwest. Wildlife Monographs 154:1–63.

Montana Natural Heritage Program (MNHP). 2009. Montana Animal Species of Concern. http://mtnhp.org/Reports/MASOC_2009.pdf

Moser, B.W. 2007. Space use and ecology of goshawks in northern Idaho. Dissertation, University of Idaho, Moscow, USA.

Patla, S.M. 1997. Nesting ecology and habitat of the northern goshawk in undisturbed and timber harvest areas on the Targhee National Forest, Greater Yellowstone Ecosystem. M.S. Thesis, Idaho State Univ., Pocatello, ID. 164pp.

Patla, S.M. 2005. Monitoring results of northern goshawk nesting areas in the Greater Yellowstone Ecosystem: is decline in occupancy related to habitat change? Journal of Raptor Research 39:324-334. Penteriani, V., and B. Faivre. 2001. Effects of harvesting timber stands on goshawks in two European areas. Biological Conservation 101: 211-216.

Reich, R. M., S. M. Joy, and R. T. Reynolds. 2004. Predicting the location of northern goshawk nests: modeling the spatial dependency between locations and forest structure. Ecological Modeling 176:109-133.

Reynolds, R. T., R. T. Graham, M. H. Reiser, R. L. Bassett, P. L. Kennedy, D. A. Boyce, G. Goodwin, R. Smith, and E. L. Fisher. 1992. Management recommendations for the Northern Goshawk in the Southwestern United States. General Technical Report RM-217, 90 pp. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO, USA.

Reynolds, R.T., Joy, S.M. and D.G. Leslie. 1994. Nest productivity, fidelity, and spacing of northern goshawks in northern Arizona. Studies in Avian Biology. 16: 106-113.

Reynolds, R.T., R.T. Graham, and D.A. Boyce. 2007. Northern goshawk habitat: an intersection of science, management, and conservation. Journal of Wildlife Management 72:1047-1055.

Reynolds, R.T., J.D. Weins, and S. R. Salafsky. 2006. A Review and evaluation of factors limiting northern goshawk populations. Studies in Avian Biology No.: 260-273 *in* M.L. Morrison. 2006. The northern goshawk: a technical assessment of its status, ecology and management.

Rickletts, T. H., E. Dinnerstein, D. M. Olsen, C. J. Louks, W. Eichbaum, D. DellaSalla, K. Kavanagh, P. Hedo, P. T. Hurley, K. M. Carney, R. Abell, and S. Waters. 1999. Terrestrial ecoregions of North America. Island Press, Covelo, California, and Washington, DC, USA.

Salafsky, S. R., R. T. Reynolds, and B. R. Noon. 2005. Patterns of temporal variation in goshawk reproduction and prey resources. Journal of Raptor Research 39: 237-246.

Salafsky, S. R., R. T Reynolds, B. R. Noon, and J. A. Wiens. 2006. Reproductive responses of northern goshawks to variable prey populations. Journal of Wildlife Management 71:2274-2283.

Samson, F. B. 2006a. (www.fs.fed.us/r1/projects/wlfecology; Accessed June 29, 2006). A Conservation assessment of the northern goshawk, blacked-backed woodpecker, flammulated owl, and pileated woodpecker in R1, USDA Forest Service. Unpublished report on file, Northern Region, Missoula, Montana, USA.

Samson , F. B. 2006b. (www.fs.fed.us/r1/projects/wlfecology; Accessed June 29, 2006). Habitat estimates for maintaining viable populations of the northern goshawk, black-backed woodpecker, flammulated owl, pileated woodpecker, American martin, and fisher. Unpublished report on file, Northern Region, Missoula, Montana, USA.

Schoenagel, T., T. T. Veblen, and W. H. Romme. 2004. The interaction of fires, fuels, and climate across Rocky Mountain forests. BioScience 54: 661-675.

Sergio, F. and F. Hiraldo. 2008. Intraguild predation in raptor assemblages: a review. Ibis 150:132-145.

Silver, R.D. et al. 1991. Letter to Dept. of the Interior, petitioning to list the northern goshawk (*Accipiter gentilis*) in Utah, Colorado, New Mexico and Arizona, under the Endangered Species Act. Maricopa Audubon Society. Phoenix, Arizona. 61 pp.

Squires, J. R., and P. L. Kennedy. 2006. Northern goshawk ecology: an assessment of current knowledge and information needs for conservation management. Studies in Avian Biology 31: 8-62.

Squires, J.R. and R.T. Reynolds. 1997. Northern goshawk Accipter gentilis. In: Poole, A. and F. Gill [eds.] Vol. 298 . The Birds of North America. The Academy of Natural Sciences, The American Ornithologists' Union, Washington D.C. 1-32 pp.

Squires, J. R., and L. F. Ruggiero. 1996. Nest-site preference of northern goshawks in southcentral Wyoming. J. Wildlife Management. 60(1): 170-177.

Squires, J.R. and L.F. Ruggiero. 1995. Winter movements of adult northern goshawks that nested in southcentral Wyoming. Journal of Raptor Research. 29: 5-9.

Swem, T. and M. Adams. 1992. A northern goshawk nest in the tundra biome. J. Raptor Research. 26(2): 102.

Thomas, J. W., E. D. Forsman, J. B. Lint, E. C. Meslow, B. R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. USDA Forest Service; USDI Bureau of Land Management, Fish and Wildlife Service, National Park Service. Portland, Oregon, USA.

United States Fish and Wildlife Service (USFWS). 1998. Northern Goshawk Status Review. Office of Technical Support – Forest Resources. Portland, OR. Unpublished Report. 250 pp.

White, C., Lloyd, G.D. and G.L. Richards. 1965. Goshawk nesting in the upper Sonoran in Colorado and Utah. The Condor. 67: 269.

Wittinger, T. 2004. Northern Region Forest Service 2004 Sensitive Species List Update Process for Wildlife. http://fsweb.r1.fs.fed.us/wildlife/wwfrp/TESnew.htm September 8, 2004.

Whitford, T.C. 1991. Defining old-growth Douglas-fir forests of central Montana and use of the Northern Goshawk (*Accipiter gentilis*) as a management indicator species. Master's thesis, University of Montana, Missoula, MT.

Wiens, J. D., R. T. Reynolds, and B. R. Noon. 2006a. Juvenile movemenbt and natal dispersal of northern goshawks in Arizona. The Condor 108:253-269.

Wiens, J. D., B. R. Noon, and R. T. Reynolds. 2006b. Post-fledging survival of northern goshawks: the importance of prey abundance, weather, and dispersal. Ecological Applications 16:406-418.

Wisdom, M. J., Holthausen, R.S., Wales, B.K. et al.. 1999. Source habitats for terrestrial vertebrates of focus in the Interior Columbia Basin: broad-scale trends and management implications. USDA Forest Service Pacific Northwest Research Station. Portland, Oregon. 26 pp.

Woodbridge, B., and C. D. Hargis. 2005. Northern goshawk inventory and monitoring technical guide. USDA Forest Service, Washington Office, Ecosystem Management Coordination Staff, Wildlife, Fish, Watershed, and Air Staff, Washington DC, USA.

Younk, J.V., and M.J. Bechard. 1994. Breeding ecology of the Northern Goshawk in high elevation aspen forests of northern Nevada. Stud. Avian Biol. 16:119-121.

Zirrer, F. 1947. The goshawk. Passenger Pigeon. 9: 79-94. (8 pp. - partial).